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TECHNICAL PAPER #34

**UNDERSTANDING DAIRY PRODUCTION
IN DEVELOPING COUNTRIES**

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Understanding Dairy Production in

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PREFACE

This paper is one of a series published by Volunteers in Technical Assistance to provide an introduction to specific state-of-the-art technologies of interest to people in developing countries.

The papers are intended to be used as guidelines to help people choose technologies that are suitable to their situations. They are not intended to provide construction or implementation details. People are urged to contact VITA or a similar organization for further information and technical assistance if they find that a particular technology seems to meet their needs.

The papers in the series were written, reviewed, and illustrated almost entirely by VITA Volunteer technical experts on a purely voluntary basis. Some 500 volunteers were involved in the production of the first 100 titles issued, contributing approximately 5,000 hours of their time. VITA staff included Maria Giannuzzi as editor, Suzanne Brooks handling typesetting and layout, and Margaret Crouch as project manager.

The author, VITA Volunteer Dr. John W. Hibbs is professor emeritus of the Department of Dairy Science, Ohio State University. As a specialist in animal nutrition and physiology, Dr. Hibbs has served as an AID/OSU adviser at the Haryana Agricultural University in Hissar, (Haryana) India and as an FAO consultant under

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VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, a specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and publishes a variety of technical manuals and papers.

UNDERSTANDING DAIRY PRODUCTION IN DEVELOPING COUNTRIES

By VITA Volunteers John W. Hibbs and Walter G. Whittlestone

I. INTRODUCTION

Dairy production in some form exists in most developing countries. Cattle, water buffalo, goats, and sheep all provide milk for human consumption in various regions of the world. In many countries, however, cattle have been developed primarily as draft animals resulting in low genetic potential for milk production.

Efforts to improve primitive dairy production practices have been undertaken to provide more and better quality milk as a source of highly nutritious food for humans, especially growing children. Most of these efforts have been in the following areas:

- o Breeding and selection of cows with higher milk-producing potential and bulls with greater transmitting ability for higher milk production.
- o Better feeding practices to help cows produce to their genetic ability.
- o Provision of a year-round supply of high quality (highly digestible) forage through improved forage harvesting and preservation and improved pasturing systems.
- o Control of infectious and metabolic diseases, some of which are associated with higher levels of milk production.

- o Better management of reproductive problems, including raising calves for herd replacements.

- o Sound milking practices, which aid in sanitation and control of mastitis.

- o Adequate housing for extremes in weather and climate.

- o Improved sanitation and cold storage of the product, especially when the milk is not consumed soon after being produced.

- o Stabilized, year-round local markets for dairy products, without which the dairy farmer cannot long survive, in view of the high investment required to initiate a successful dairy program.

- o Provision of low-interest bank or government loan credit, which can encourage beginning dairy farmers to make the initial investment in cattle and facilities.

II. DAIRY PRODUCTION PRACTICES

The dairy industries in many industrialized countries have developed elaborate facilities in an effort to: (1) save labor, which is plentiful and inexpensive in most developing countries; (2) provide protection for both the cattle and their caretakers from cold in winter; and (3) provide sufficient sanitation and refrigeration to ensure the keeping qualities of the product, for

shipping, long shelf life, and manufacturing procedures. It should be kept in mind that very elaborate facilities are not always necessary. In tropical countries, for example, cattle do not need shelter from cold winters, and areas where milk is consumed quickly and locally have different storage requirements. Relatively high levels of milk production can be achieved without elaborate facilities, and the dairy operation can be upgraded gradually as economic conditions permit.

Improving dairy production begins with careful attention to breeding in order to improve native cattle, to feeding practices so as to assure good diet year-round, and to the harvesting and preservation of forage.

BREEDING AND SELECTION

While the most rapid progress in increasing productivity can result from raising or importing purebred European breeds, these breeds are more susceptible to disease and extreme climatic conditions, and the initial cost is higher. However, where high standards of disease control and management of the environment are possible, purebred European breed cows can do well in hot climates if properly fed. This point has been demonstrated in Israel where milk production of Holstein cows rivals that of the most developed countries. It is also possible to start with cows of native dairy breeds (mostly Zebus) and grade up the herd through cross breeding, but this requires more time.

In some developing countries, rapid progress has been made in

increasing the milk-producing ability of cows through the use of bulls or semen from European dairy breeds, notably Holstein, Brown Swiss, Jersey, and Red Dane. In India, for example, the offspring from native cows bred to Holstein or Brown Swiss bulls produced about double the milk per lactation of the native cows, approximately 3,600 pounds/lactation. This amount is about the same as that produced by the Murrah water buffalo. The offspring of the crossbred cows bred to bulls of European breeds have the potential to produce even more, if fed in such a way that their genetic potential can be reached. Often they are not adequately fed. Cows possessing one-fourth to one-half native breed genes will retain some of the disease resistance of the native breeds and will be more resistant to heat than purebred cows of the European breeds.

In view of the wealth of knowledge, gained through extensive research in all phases of dairying around the world, most developing countries would be well-advised to put emphasis on the application and extension of existing knowledge rather than on repetitious research, at least in the early stages of development. This applies not only to breeding but to all phases of dairy production.

HERD MANAGEMENT

Herd management is a major key in meeting the highest potential of milk production for each cow. Careful management will make the cow as comfortable as possible and reduce many elements of stress that would adversely affect the animal's production.

Animal health is an important factor. For all age groups, one needs to pay attention to a number of health practices. In particular, there should be a good vaccination program for the diseases common to the region (e.g., hoof and mouth, brucellosis, rabies, etc.) It is also important to have a regular parasite control program against internal and external parasites. Parasites adversely affect the animal's production and lower its resistance to disease and infection. In case of serious illness or injury, veterinary advice is strongly recommended.

Providing housing or shelter is another step in making it possible for the animal to reach its potential. The housing or shelter can also be used for milking, making it more sanitary and comfortable for the owner and cow alike. There are various setups available for efficient dairy production. These include stanchions (a device that fits loosely around a cow's neck and limits forward and backward motion) and parlors. For a small dairy, a simple stall is adequate. Dairy set-ups such as these make the milking operation more efficient and also provide the individual attention the animal needs. Sanitation is the most important aspect in the milking process: The milking area and all utensils (buckets) should be clean.

FEEDING AND NUTRITION

After procuring cows with the genetic ability to produce large quantities of milk, it is important for dairy managers to develop a "Production Philosophy of Feeding" as opposed to the all too

common "Survival Philosophy of Feeding," which limits intake to minimum daily requirements.

In warm climates, where some type of edible forage is available all year-round, the common practice is to feed whatever is available that can be cut daily or scavenged by the cows. This forage is often referred to as "green fodder" and may vary from high quality berseem or alfalfa (70 percent digestible dry matter), often in limited amounts, to mature sorghum, millet, corn, mustard, etc., depending on the area involved and the season of the year. This "green fodder" is often mixed with wheat straw (wheat bhusa), rice straw, and other poorly-digested roughages and supplemented to some extent with oil cake. This type of feeding offers survival but low milk production.

To ensure that cows will produce to their genetic ability, a uniformly high digestible source of nutrients must be supplied year-round. In most situations this will require harvest and storage of high-quality forage(s) for use when good "green fodder" or good pasture is not available.

Research has shown that, when the dry matter digestibility of the diet falls below about 67 percent, voluntary feed intake decreases with declining digestibility. This decline is associated with the indigestible residue in the intestinal tract and the slower rate of digestion.

When the digestibility of the diet is maintained above about 67 percent, digestibility and the rate of digestion no longer limit

intake, and other factors, including nutritional needs for production, govern voluntary intake. For cows to attain a maximum voluntary feed intake and produce to their capabilities, they must be fed a highly digestible diet, balanced for protein, on a year-round basis.

The poorer the quality of the roughage, that is, the lower its digestibility, the more grain concentrate (high in digestibility) is needed for adequate feed intake. Of all the nutritional factors that influence milk production, digestibility of the diet, as related to feed intake, is the most critical. If good cows are limited in feed intake, they can not reach their producing potential.

Table 1 clearly illustrates the effect of the stage of maturity of the forage on protein content, dry matter digestibility, voluntary intake, fecal dry matter excretion, milk production, and the the amount of concentrate, balanced for protein, needed to maintain milk production as the forage matures and its digestibility declines. The forage in this experiment was cut and chopped daily and fed individually free choice (eat at will) to the Holstein and Jersey cows.

TABLE 1.

Effect of Stage of Maturity of Grass-Legume Forage
on Dry Matter Intake, Digestibility, and Milk Production 1.2/

Stage of Total Dry Matter Forage Dry Digestible Fecal Dry Milk Amount of

Day Maturity of Protein Digestibility Matter Intake Dry Matter Matter Production Grain

Alfalfa (Percent) (Percent) lb/day/1,000 Intake lb/day/1.000 lb/day Needed
 lb body wt. lb/day/1,000 lb body wt. lb/day 3/
 lb body wt.

May 17 Pre-bud 21.9 66.8 34.4 23.0 11.1 42.5 3.0

May 24 Bud 18.9 65.0 33.2 21.6 11.6 39.2 5.7

May 31 Early Bloom 15.9 63.1 32.0 20.2 11.8 34.0 8.4

June 7 Mid Bloom 14.0 61.3 30.6 18.8 11.8 31.4 10.9

June 14 Full Bloom 12.0 59.4 29.2 17.4 11.8 26.5 13.5

June 21 Late Bloom 10.0 57.5 27.8 16.0 11.8 23.4 15.7

June 28 Mature ---- 55.8 26.3 14.7 11.6 19.5 18.2

1 Data taken in part from Ohio Farm and Home Research, 46 (May-June 1961): 3,
 and Ohio Agricultural Experiment Station
 Research Bulletin 914 (June 1962)

2 Fresh chopped forage fed daily free choice with only 3 to 5 pounds of
 concentrate/day respectively to Jersey and
 Holstein cows. Data shown are weekly averages.

3 The amount of grain concentrate, balanced for protein, needed per 1,000 pound
 cow to have maintained the level of
 production on May 17, 42.5 pounds/day.

In a six week period, protein content decreased more than half from 21.9 percent to less than 10.0 percent; dry matter digestibility declined from 67 percent to 56 percent; and voluntary forage intake fell from 34.4 to 26.3 pounds/day/1,000 pounds body weight. It is interesting to note that fecal dry matter excretion remained nearly constant at about 11.8 pounds/day/1,000 pounds body weight. Thus, as digestibility of the forage declined, cows were able to eat less and less forage in a 24-hour period. However, as a result of their limited feed intake, milk yield from these cows declined by 50 percent, from 42.5 to 19.5 pounds daily.

The Holstein and Jersey cows in this experiment were fed a concentrate mixture at the daily rate of 5 and 3 pounds, respectively. The last column in Table 1 gives the estimated amount of grain concentrate, balanced for protein, that would have been necessary to feed in order to have maintained the initial level of milk production of 42.5 pounds/day. While only 3-5 pounds was fed at the beginning, 18.2 pounds/1,000 pounds body weight would have been needed six weeks later when the forage had matured. Thus, the poorer the forage quality, the more concentrate must be fed to maintain production.

In hot climates maturity of forages advances even faster and low digestibilities are reached in a shorter time. It is clear, therefore, that forages should be harvested in an immature stage of development. Legumes (berseen, alfalfa, etc.) should be harvested in the pre-bloom stage, and grasses in the boot stage (pre-emergence stage of the head). The same principle applies

whether the forage is harvested daily; cut, dried, and stored as hay; cut, wilted, and ensiled; or harvested as rotated pasture by the cows.

Grain concentrates, including cereal grains, protein supplements, and by-product feeds can be used to supplement the forage to provide a balanced diet. The amount and content of the concentrate will depend on the level of milk production and the quality (digestibility) of the forage.

FORAGE HARVESTING AND PRESERVATION

In seasons when there is ample sunshine and warm temperatures, hay-making is the best method of preserving legume and grass forages. When weather does not permit hay-making without frequent loss of the crop, silage can be made, after wilting to 35 percent or 45 percent dry matter for best preservation. If silage is put up wetter than 35 percent dry matter, it may spoil or be of poor quality due to abnormal fermentation. If much dryer than 45 percent, it may heat in storage to the point where the protein is rendered indigestible.

Chopped forages can be made into silage in a number of ways: (1) pits; (2) stacks covered with plastic to exclude the air; (3) trenches; (4) bunkers; (5) upright silos, which are more expensive. The most important factors for producing good silage are:

(1) harvesting the forage in an immature stage (legumes in the pre-bloom stage and grasses in the boot stage); (2) chopping and

careful packing to help exclude air; and (3) ensiling at the proper dry matter content--after wilting to 35-45 percent dry matter.

In hot climates, forages become harsh and brittle when dry and the leaves, especially legumes, fall off quickly when handled. This is a loss of nutrients, because the leaves contain most of the protein, minerals, and carotene-pro-vitamin A. The following method of hay-making will result in low leaf loss, and can be practiced by small village farmers to help provide a year-round supply of high quality forage for their cows:

1. Cut and chop the forage. Many farmers have access to either a hand- or motor-driven chopper (chaffer).
2. Spread the wet green chopped forage in the sun on a smooth clean surface (threshing area, roof top, courtyard, roadway, etc.).
3. Stir the forage frequently to hasten drying.
4. When dry, the leaves and chopped stems can be easily gathered together without separation, and can be moved to storage or to market by head load, bullock cart, or truck.

Any storage place in the village normally used for straw (bhusa) or grains, such as thatched or mud-covered stacks or rooms in buildings, can be used to store the chopped dried hay, either bagged or loose. Any excess dried hay can be sold for a good price as a cash crop in seasons when good forage is in short supply. Prices should be based on the dry matter content of the hay (100 pounds of dry forage at 90 percent dry matter would be worth the same as 600 pounds of wet forage at 15 percent dry

matter) .

MILKING AND MILK HANDLING

Many developing countries are tropical, which makes good hygiene difficult. More than 10 percent of the milk produced in India, for example, is lost due to spoilage. Thus, good hygiene means more milk for human consumption.

The essential problem is to prevent contamination right from the moment the milk leaves the udder. Likewise, cooling should start as soon as possible. The approach to hygiene depends on the facilities available. For example, in Israel there is often no cooling water but plenty of sanitizers, while in parts of India the reverse may be true. If ice-making facilities are available at the milk collection center, hygiene can be greatly improved.

In developed countries, the use of machines to milk the cow and cool the milk is widely practiced. But for a very small dairy operation in a developing country, it is not recommended nor economically feasible to start up with a milking machine. The price of equipment, whether new or used, is extremely high and importing milking equipment and parts to a developing country might be difficult. Operators of larger dairies, where capital costs may be met more easily, may wish to consider milking machines because they offer important advantages in maintaining milk quality.

Hand Milking

Water Buffaloes. This animal milks best if it has been washed or sprayed with water before milking. The custom of pouring water over the animal before milking is common in India and has the unfortunate effect of washing the dust and dirt on the animal's body down round the udder and teats from which it may run over the milker's hands and into the milker's pail with disastrous effects on hygiene!

The ideal solution to this problem is to have a wallow such as part of an irrigation ditch where the buffaloes may actually swim on their way to the milking shed. They should then stand in a shady place to "drip dry" before milking. This is a good time to feed any supplements and adds further to the animal's contentment before milking. It is essential to have shade--buffaloes hate hot sunshine.

If a wallow is not possible a simple shower bath is good but care is needed to ensure that enough water is used to wash away the dirt that runs off. Such water need not be wasted--it has a place in irrigation or even in washing down the cattle yards before going into the irrigation system. "Drip drying" is essential after a shower. When water is not available, good shade is even more essential in the yards at milking time. In this case, it is best to wash just the teats and lower udder. This part of the animal is part of the cooling system due to the vascular mechanisms in the teats. Washing thus helps to make the buffalo comfortable and if only the lower part is wetted it is possible to mop off the excess water. If possible all washing

water used this way should contain at least 200 parts per million of chlorine. Just before hand milking, all water should be squeezed off by hand. An udder cloth is not recommended.

Full hand milking should be carried out. The "stripping" method common in India is damaging to the teats. The buffalo is a "tough" milker but despite this, milk should be squeezed out with full hand pressure, not by wringing the teat between thumb and fingers. After milking, the teats should be dipped in a chlorine solution.

Cows. This animal does not need the "water treatment," but shade is desirable for holding yards. As with the buffalo, good stimulation by rubbing the udders and squeezing the teats before milking is needed. Unless adequate washing water with chlorine in it is available, it is best not to try to wash more than the teats and lower parts of the udder. Full hand milking is essential.

It should be emphasized that the milking of both buffaloes and cows should be carried out with the teats as dry as possible. The custom of dipping the milker's hands in the milk to provide "lubrication" for hand milking is quite unacceptable: It is a major cause of bacterial contamination of the milk. If a lubricant is thought to be essential, the use of coconut oil in small quantities is helpful. Coconut oil is added to soap made from this oil to make an udder wash. A small quantity of the creamy mix is rubbed onto the udder surface and teats and washed away with a final squeezing away of residual water. This makes an

excellent cleaner/emollient.

Machine Milking

All of the rules for good hygiene apply to machine milking. However, mechanical milking makes it possible to reduce greatly the potential for contamination of the milk. Experience with machine milking buffaloes in India showed that there is an enormous improvement in milk quality, as measured with the reductase test, by using a simple direct-to-can milking system. The udders were washed with chlorine solution with much rubbing and stimulation, excess water removed and the machine applied without delay. Likewise in Israel it has been shown that milking into a tank on wheels and taking the milk to the cooling and collection center as soon as milking is complete can result in good quality milk even though there are no cooling facilities on the farm. This is due to the transient anti-bacterial properties of freshly drawn milk. There is little bacterial growth for the first half hour after milking.

The transport cans or mobile tanks are thoroughly washed at the collecting center and returned with a quantity of chlorine solution in the bottom. This keep the vessels sanitary until needed when the chlorine solution may be used for rinsing the milking equipment and finally for washing the udder and teats.

Any farmer milking more than 10 cows or buffaloes or 20-30 goats will probably find that a simple machine is worthwhile if only because of the improved milk quality made possible by mechanical

milking. The machine may be kept sanitary by soaking the milk handling parts in caustic soda between milking and rinsing with chlorine solution before milking.

The milking of sheep and goats requires the same preparation methods and general hygiene as for cows.

Care of Utensils

All milk containing vessels must be covered at all times. The milker's bucket should have a partial cover to minimize dirt falling in during milking. The receptacle into which the milk is poured from the milker's bucket must be covered and provision made for cooling when possible. A simple immersion cooler is very helpful. Ideally, the milk should be refrigerated.

All vessels used for milk must be thoroughly scrubbed with a detergent or soap. They must be rinsed with chlorine solution. The latter is easily prepared when not available by passing an accurately known amount of chlorine solution. The latter is easily prepared when not available by passing an accurately known amount of chlorine gas into a fixed amount of caustic soda solution. This can be done cheaply by using a concrete pipe as the receptacle, hanging the chlorine cylinder from a spring balance, and bubbling in the right amount of gas. The solution is about 2.5 percent chlorine and is diluted to 200 parts per million for use.

Milk Cooling

When ice can be made at the milk collecting center or dairy factory it is possible to improve the hygiene of milk transport. The cans are fitted with lids that have a cone-shaped attachment into which broken ice may be placed. When the can is filled to the appropriate level the lid is fitted and the cone filled with ice which then cools the milk on the way to the collecting center. After delivery of the milk the can is cleaned and filled with pieces of ice for the return trip. The ice is kept under some sort of insulating cover until required at the next milking. This crude form of refrigeration combined with machine milking makes possible the production of reasonable quality milk under difficult conditions.

New Developments in Hygiene

The "Alpom" System. This is a preservative based on the natural anti-bacterial properties of fresh milk. It contains peroxide and the enzyme lactoperoxidase. When mixed with the calf's saliva, which contains thiocyanate, a very anti-bacterial substance of short life is produced. The artificial addition of peroxide and thiocyanate will inhibit bacterial growth for a significant time. This method works for the milk of cows and buffaloes but there are problems with goat milk because of the chemistry of goat casein.

Thermization. (*) By the use of heat well below pasteurizing temperature and thus not affecting the flavor of milk, it is possible to inhibit bacterial development for a time. Thermization

is best done as soon as the milk is drawn and before it is cooled for transport. The use of solar energy for heating the milk is attractive in tropical countries and there is need for research on this aspect of milk quality control.

Other Developments. There are a number of developments in the advanced dairy countries that hold promise for developing countries. These have arisen because of the fuel crisis. One is the use of the roof of the cow shed, painted black, as a solar absorber during the day to provide hot water. At night, water is trickled over the open roof and radiation of heat into the night sky results in substantial cooling of the water, which is stored in a tank.

Another widely used practice is to spray water into the air or run it over coke in a tower, thus causing evaporation. In a dry climate this is a good way to produce cool water for milk cooling.

A more sophisticated approach is to use solar energy to drive an absorption refrigerator. The capital cost is high at present but there is little maintenance and operating costs are low.

(*) Thermization is conventionally carried out at 66[degrees centigrade] for 15 seconds.

EQUIPMENT NEEDS

The equipment needed for dairying can be rather simple:

- o Enclosed buildings may be needed, depending on the climatic conditions.

- o Milking facilities should include some way to restrain cows while being milked, e.g., tie stalls, stanchions (a device that fits loosely around a cow's neck and limits forward and backward motion), either outdoors or in a building.

- o Cleanable utensils are essential for receiving the milk at milking time and storing the product until used or sold. Facilities should be available to keep utensils clean. This includes plenty of clean water and if possible, sunlight for drying and holding down bacterial growth.

- o If the milk is to be held for more than a few hours, some cooling device will be needed.

- o Feed mangers (a trough or open box in a stable designed to hold feed or fodder for livestock) of some kind for feeding hay, silage, and concentrates, not necessarily in the milking area.

- o Cattle on pasture will require fencing or herding to keep them from straying or destroying other crops.

- o If milk is to be transported, some means of conveyance and utensils for holding it will be needed. In some

areas, bicycles are used for transportation to market. This will depend on local conditions.

The above facilities can be developed to whatever degree of sophistication economic conditions warrant.

III. STARTING A DAIRY BUSINESS

Serious thought should be given to the most simple entry into milk production. A very good option for the first step is dairytype goats. If the area has insects and diseases that are potent enough to require natural resistance, start with the native females and breed with the milkiest imported males or frozen semen.

Teach the youngest children to like to drink the goat milk first and then work up the age groups. Any milk that cannot be used immediately should be cooled to the temperature of the coldest well water of the area as soon as it is milked. Since most developing areas do not have cheap electricity and refrigerators in homes, any cooperative milk plants should consider making dried milk powder or the new sterilized milk containers to provide long shelf life without refrigeration.

If the area has plenty of moisture, plant the highest protein variety foliage and time the rotation of the pastures so that the grass is eaten at a young age not to be too high in fiber or too low in protein. Similarly, if the grass is cut for hay, cut it often enough so that the fiber content is not too high and the

protein is still good. If fertilizer is reasonably priced, the right kind and proportion can make the foliage much more nutritious.

When the goat dairy is running well, and you can produce plenty of good quality roughage and enough quality dry hay or ensilage to tide you over during periods of dry weather, you are ready to consider dairy cattle. Jersey cattle may adjust to extra warm and humid climates better than other breeds since they are smaller in size and the milk is higher in solids and protein. If you import dairy females, consider only the type cattle that produce milk at least cost, especially on roughage alone. Obtain advice from those who are experienced in paying their bills with milk checks.

IV. SUMMARY

Space does not permit a full discussion of all of the important areas in dairy development. However, the farmer can go a long way toward success if careful attention is paid to the initial selection or development of productive breeding stock, application of the basic principles of feeding and nutrition, and the provision of a year-round supply of high-quality forages, properly supplemented with grain concentrate.

In many areas assistance with balancing rations, controlling diseases, and other aspects of dairy management can be obtained from veterinarians; dairy specialists located at agricultural universities; the extension service in some countries; and organizations such as VITA, Winrock International, The Heifer

Foundation, the Peace Corps, Ford Foundation, and Rockefeller Foundation.

Much concern has been expressed about the competition of dairy cows with human beings for cereal grains. It should be kept in mind that cows consume large amounts of feeds humans cannot eat. Nearly all the supplemental protein fed to cows in the form of cereal grains and oil cakes is returned as high-quality milk protein. If urea is fed at recommended levels in the concentrate mixture, there may be a 40 percent increase in milk protein above that consumed by the cows in the form of protein edible by humans.

An integral part of a country's dairy and livestock industries is the development of a reliable feed industry to foster the economic utilization of cereal and agricultural by-products, urea and protein, and mineral and vitamin supplements. Feed companies should be dedicated to the philosophy that "what is good for the farmer is good for them!"

The potential for dairy production will rise rapidly as improved breeding, feeding, management, and disease control practices are established. Thirty years ago in the United States the better dairies were producing Holstein herd averages of about 10,000 pounds of milk/cow/lactation. Today the best averages are 20,000 pounds/cow/lactation. Much of this increase is due to better feeding methods and the widespread use of artificial insemination using bulls proven to transmit high milk producing ability.

It is important that dairy operators in less developed areas of the world employ the best dairy production practices within their financial means. Progress, although often slow, will be certain for those who are persistent and anxious to learn.

BIBLIOGRAPHY/Suggested Reading List

Bearden, H.J., and Schultz, L.H. Recommended Milking Practices. Ithaca, New York: New York State College of Agriculture, Cornell University, October 1961.

Bradt, C.G. Dairy Herd Management for Health Production and Longer Life. Ithaca, New York: New York State College of Agriculture, Cornell University, May 1960.

Burgwald, L.H., and Strobel, D.R. How to Use Recombined Milk Ingredients in Manufacturing Dairy Products. Washington, D.C.: U.S. Department of Agriculture, 1957.

Colby, B.E. et al. Dairy Goats: Breeding, Feeding, and Management. Publication 439. Amherst, Massachusetts: University of Massachusetts, College of Agriculture, 1966.

Conrad, H.R.; Pratt, A.D.; and Hibbs, J.W.; "Regulation of Feed Intake in Dairy Cows," Journal of Dairy Science. Vol. 47, 1964, pp. 54-62.

Food and Agriculture Organization. Animal Husbandry--What Cattle

Produce. Rome, Italy: Food and Agriculture Organization, 1970.

Furry, R.B. Basic Arrangements of Milking Parlors with Stall Barns. Ithaca, New York: Cornell University Agricultural Experiment Station, April 1962.

Gall, C. "Milk Production from Sheep and Goats, "World Animal Review. No. 13. Rome, Italy: Food and Agriculture Organization, 1975, p. 108.

Guthrie E.S. Making Butter on the Farm. Cornell Extension Bulletin 751. Ithaca, New York: New York State College of Agriculture, Cornell University, 1948.

Higgs, J.W. "Preservation of High Quality Legumes as Hay in Hot, Semiarid Regions." World Review of Animal Production XV, 1979, pp. 23-27.

Huff, H. "A Goat Milking Stand," Mother Earth News. January 1980, pp. 176-177.

Jamaica Livestock Association. Livestock Manual for the Tropics. Kingston, Jamaica: Jamaica Livestock Association, January 1983.

Kidd, R. "From Milk Pail to Supper Table." Mother Earth News, No. 72, November 1981, pp. 78-80.

Kidd, R. "Ten Commandments for Raising a Backyard Dairy Cow: Part I," Mother Earth News, No. 70, July 1981, pp. 64-66.

Kidd, R. "Ten Commandments for Raising a Backyard Dairy Cow: Part II," Mother Earth News, No. 71, September 1981, pp. 88-89.

Kosikowski, F.V. and Holland, R.F. The Sanitary Care of Milking Equipment on the Farm. Cornell Extension Bulletin 941. Ithaca, New York: New York State College of Agriculture, Cornell University, 1963.

Wells, M., and Hobbs, W. Construction and Sanitation Requirements for Producing Clean Milk. Experiment Station Bulletin No. 33. Addis Ababa, Ethiopia: Haile Sellassie University, 1965.

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