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418/2007

Good Dairy Farming Practices related to Primary Production of Milk and Farm Management

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Good Dairy Farming Practices related to Primary Production of Milk and Farm Management

Foreword

IDF's World Dairy Summit and 27th IDF World Dairy Congress in Shanghai, China, in October 2007 was no doubt a very interesting experience for all those who participated, including the Chinese hosts. As the programme comprised a great variety of conferences, workshops and seminars, diverse both in approach and topics, the proceedings of the event will be published according to the nature of each conference, seminar or workshop in peer-reviewed journals or in the Bulletin of the IDF.

This issue of the Bulletin of IDF contains several papers presented at the conference on Good Dairy Farming Practices related to Primary Production of Milk and Farm Management, which was organized with the support of the Food And Agriculture Organization of the United Nations (FAO).

The conference highlighted the challenges to which farmers all over the world are confronted and the importance of Good Farming Practice, with particular emphasis on the needs of developing countries.

The IDF is grateful to the Programme Committee (Y Lu (CN), R Engelman (CN), A Speedy (FAO), J Wang (CN) and T Morgan (GB)) for developing the programme, to the moderators for conducting the sessions and of course to the authors of the papers for their valuable contribution.

Christian Robert
Director General
August 2007

Introduction

T. Morgan[1]

The emphasis on Primary Production and Farm Management is of particular importance as the farmer throughout the world produces the milk on which the subsequent parts of the industry depend.

The farmer as a primary producer in the supply chain must see himself as a food producer and as a food producer he must ensure that his method of production will satisfy the needs of the food industry and ultimately the consumer.

The challenge is to develop sustainable production systems that produce safe food, enhance the environment, protect animal welfare and improve dairy farmers economic viability.

The Supply chain in dairy products is global and the exacting demands of the consumer worldwide places a responsibility on all in the supply chain, including the farmer, to demonstrate good practice.

The World is increasingly being asked to feed a growing population and this pressure will give an impetus to the adoption of new techniques in milk production and processing. Population increase drives growth in demand and this demand is moving quickly away from the large traditional developed markets of Europe and North America to the developing world of Asia, North Africa and Latin America.

Income growth is higher in those regions than the world average figure of 3.10%.

A 1% income growth in the developed countries increases dairy consumption by .25% while in the developing nations of China and India, or in Africa the ratio is 1 to 1, so a 1% income growth increases dairy consumption by 1%. Rising affluence means that more people can afford the high-value protein offered in dairy products.

As the wealth of these nations increases this often quoted example may well illustrate the opportunity in the dairy industry. If every person in China consumed 250 grams/day of dairy products it would consume nearly 20% of world output. This market opportunity is most likely to be taken by Southern Hemisphere countries where we see growth in supply. The ability to react to this increase in demand will be in those countries that have the lowest cost of production. This is most likely to be in Asia, especially China and India, and in Latin America, in countries such as Chile and Argentina. Although future growth may well be consumed within borders, Russia and the Ukraine along with the emerging nations of the EU could have an effect on international markets.

The increasing urbanisation in Asia and Africa will lead to a more sophisticated market in the retailing of milk and dairy products. Attaining the standards expected by the consumer may well be difficult and could be a barrier to growth and development of the dairy industry. This leads to the conclusion that dairy producers will need to apply Good Dairy Farming Practices in order to have an effect on their return and influence the efficiency of production. This of course is the challenge that the IDF and FAO have recognized. The objective of the IDF Standing Committee on Farm Management is to address farm level issues of international importance for the Dairy sector that impact on food safety and producers income.

The IDF Action Team on Dairy Farming Practices identified 5 elements that are to be managed :

1. Animal Health
2. Milking Hygiene
3. Animal Feeding and Water
4. Animal Welfare
5. Environment

Each area has a number of key control points to be managed and indeed we see different countries addressing each according to local production systems.

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The IDF Standing Committee on Farm Management intends to expand each heading into code of practices. At the IDF Summit in Vancouver a decision was made to develop a code addressing the welfare of animals in milk production. There is of course already a basis of work done in various countries and what would be of value is a worldwide set of parameters concerning animal welfare. Certainly in the developed countries we see a considerable growth in the interest shown by the ethical consumer in the provenance of dairy products and the method of production. In the UK, BSE and the recent Foot and Mouth crisis has brought greater scrutiny by the consumer of the management practices employed in the husbandry of the dairy cow. There is no doubt that in the light of climate change, greenhouse gas and other problems Good Agricultural Practice in the dairy sector will be highly relevant in local and global context. The march of progress is as relentless in the dairy industry as in any other industry quite often more so as the dairy farmer is quick to embrace new ideas and technology. The falling value of the farm output against the rising value of the inputs needed to produce a litre of milk still is the big challenge.

The past generations would be surprised at the production obtained from each hectare of land, which has been achieved with improved plant breeding and agronomy. Likewise, better breeding coupled to higher quality feed fed in a more balanced ration has driven higher milk yields. Change leads to progress and the reasons for change are many - economic pressure, hunger, the threat of war and the need for both countries and individuals to be self sufficient. Change has allowed Dairy Farmers around the world to employ their entrepreneurial skills in order to progress the dairy industry.

As the dairy industry grows and develops globally we see regulation increasing, very often at a faster rate than the industry can adapt.

The IDF, through its Dairy Farming Practices Action Team, aims to put in place a framework to be used by the producer to self regulate his own business yet still allowing him to use his enterprise and entrepreneurial skills. Those skills will drive farmers to respond to market incentives, to add value and adopt new farming methods, but success will be measured by the rate with which socially and environmentally accepted practices come to characterise dairy farming activities.

The multitude of challenges within the dairy sector will by definition create a multitude of opportunities. The milking cow population of the world, 250 million, supports a multitude of families, communities, and peoples who rely on those cows and their milk to generate opportunities to improve their lives.

1. Current production methods and problems of feeds and feeding of cattle in China

J. Wang[1]

1.1. Introduction

China has a long history of consuming milk and dairy products in ethnic minority areas, whereas milk production meets a rapid progress and its position in animal production has been significantly increased only in recent years. In 1999, the milk output was only 7.17 million tons with less than 7 kg of per capita milk output. However, since 2000, along with the increase of residential income level and the issue of a series of policies by the state, dairy industry has entered a high-speed development phase. Milk output in 2005 reached 27.3 million tons, an increase of 3.3 folds over that in 2000. Viewing the historical growth rate, the growth rate in 2000 was 15.3%, 23.9% in 2001, 26.7% in 2002, 34.4% in 2003, 31.0% in 2004 and 19.3% (a slight decline) in 2005. Through this round of development, the proportion of dairy industry in animal production has increased from less than 2.25% to 6.05% and the dairy industry had become a hotspot in agriculture and a key industry among all other industries related to national economy and social progress.

1.2. Current Situation and production systems of Dairy farms

Rapid growth of dairy cattle population has played an important role in the growth of milk production. By the end of 2005, the number of dairy cows continured to increase and about 12 million remained in 2005 (Figure 1), with an increase of 2.46 folds over 2000 and an average annual growth rate of 19.5%. In the 19.03 million tons of milk output increase from 2000 to 2005, an increase of 12.05 million tons was because of the increased number of animals, which accounted for 63.3% of the total milk output increase. However, more than 70% of dairy cattles are distributed in north China, such as Heilongjiang, Inner Mongolia, Xinjiang Autonomous Region, Hebei, Shandong, Shanxi, Shaanxi province and Beijing Municipality. Accordingly, milk production from the north China also accounted for over 70% of the national total.

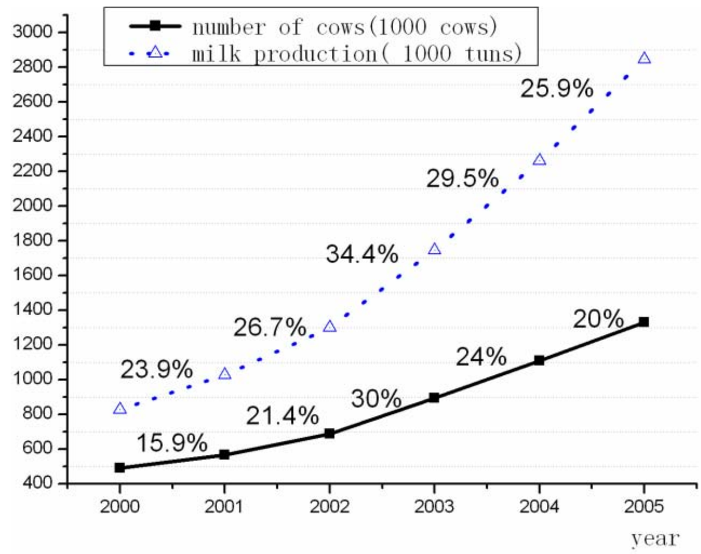

Figure 1. Number of Dairy cattle in China (2000-2005)
Source: China Dairy Industry Yearbook (2003~2005)

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Steady increase of milk production per cow has played an active role in the growth of milk production also. By 2000, the average milk production per cow was 2821 kg and reached 3791 kg in 2005, with an average annual increase rate of 194 kg, which is higher than the increase rate of 123.4 kg in the major milk producing countries in the world during the same period. The contribution rate of the increase of milk production per cow has reached 36.7% of the total milk production increase.

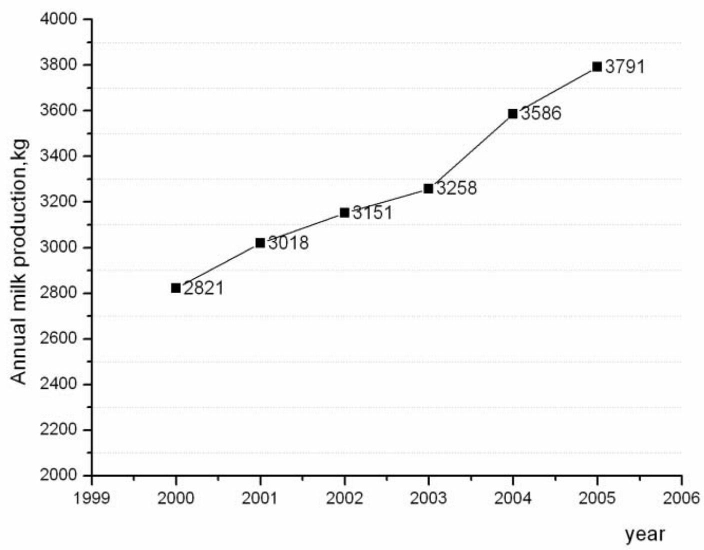

Figure 2. Annual production of milk per cow in China (2000-2005)

The number of dairy farms continued to decline at a higher rate than in previous years. Whereas farm size tends to scale-up with development of cooperative farms of small farmers, herd size in China changed dramatically from 2002 to 2005 (Figure 3). In 2002, about 45 percent of all cows were housed in herds with less than 5 cows. In 2005, only about 30 percent of cows were housed in herds of that size. In addition, almost 10 percent of cows were found in herds of 500 or more cows.

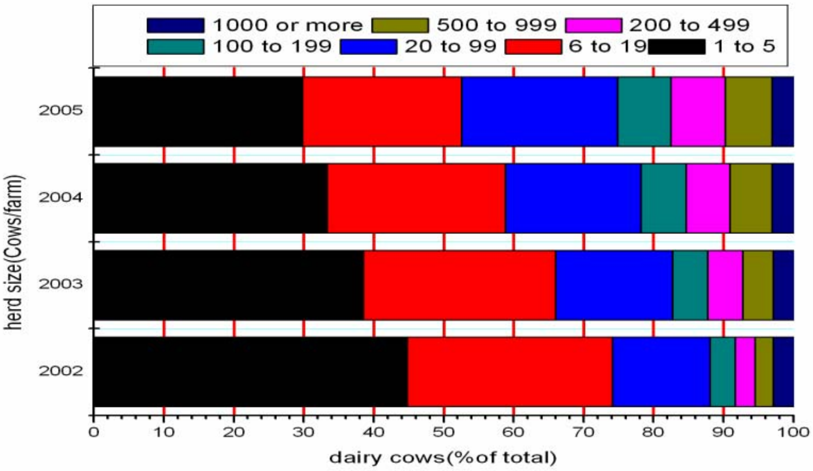

Figure 3. Herd size in China from 2002 to 2005.

There are three types of dairy farming in China: pastoral area, agricultural area and suburb area around big cities. China has a large pastoral area, however, limited by ecological and climate conditions, dairy farmers in pastoral areas basically produce milk for their own consumption, and as a result the commercial level of their dairy products is very low. More than 50% of the total dairy population is located in agricultural or conjunction area between agricultural and pastoral areas; they are the major providers for raw milks. Small rural farmers have 3 to 5 heads of dairy cows and this is the major production style in these areas, milk production level is relatively low. There are large-scale dairy farms in the urban areas surrounding big cities, carrying about 1 million heads of dairy cattle, with high milk production level, they mainly provide milk for urban residences in the cities.

Currently there are two kinds of farming systems to be developed in China. The first one would be the Large-scale intensive dairy farms in urban areas: on average these farms have more than 1000 heads of cattle, with mechanized production system, automatic management system and pollution-free manure disposal system. Because small-scale dairy farms make up around 80% of the farms in China, they contribute significantly to the nation's raw milk supply and to the local economies. They strengthen rural communities and contribute to a diverse and pleasing rural landscape. Therefore, the other farming system would be small rural farmers organized by a model of "company + base + farmers" in agricultural areas: with the support from the local government, scattered farmers will be feeding their dairy cattle in a unified programmed centralized farming area, milk processing companies provide technical training and technical services, unified feeding and management style, unified feeding ration and centralized milking machine.

1.3. Challenges and major problems facing the development of small dairy farms

As the population and standard of living continue to increase, the demand for milk products will continue to increase in China. Therefore, there will be several technical and educational resources, such as government support and application of advanced dairy science and technology, available to assist small dairy farms to develop and operate a profitable farm business. The Chinese government has the special policies, key specialized project and free cooperative extension services related to small dairy farms. However, small dairy farmers face a number of problems. Basically, they have limited purchasing power (small quantities and no discount), limited availability to markets (low volume), limited availability of custom field word (small fields), limited farm knowledge and experience (new to agriculture) and also they have limited resources, such as land, equipment, etc. Below is a list of major problems facing small farmers. Below is a list of potential challenges/problems facing small farms.

1.3.1. Fine-breed animals

Lack of superior genetics in dairy industry is an important limit factor. In the total number of 6 million heads of dairy cattle, only about 30% of the population are pure breed dairy cattle, the rest of them are crossbred cattle in the first or second generations, with low production potential and poor value of being used as seed-stock.

1.3.2. Quality and safety of feeds and feeding management

Although the development of dairy industry brings about the rapid development of feed industry, the feed quality and safety are still facing small farmers. The challenge to small dairy farmers firstly is to increase the efficiency of conversation of feedstuffs into dairy products, which includes the use of more alternative feedstuffs, such as variable agricultural by-products, so that an adequate supply of dairy products can be provided. If feeds and diets are poor and inadequate diet, even top genetics are not profitable. However, the corn was used as the primary energy source in cattle rations and the nutrients were usually not balanced well. Quality forage feeding is foundation of dairy business. Cows need quality forage to produce maintenance plus milk. China has long taken cereal crops as the major crops in crop husbandry, leading to the shortage of high quality grass for dairy cattle. Straw as only forage and concentrate results in low fiber as cow consumes little straw and excess grain. On purpose of getting more milk by adding additional cereals usually cause a serious of health problems to cows, such as dystocia, ketosis, left displaced abomasums and lameness, etc. Most small dairy farmers fed cows with concentrates and forages separately. There is no available TMR machine, which can be used successfully in small farms at present.

1.3.3. Application of advanced science and technology

Most small farm operators come from non-farm backgrounds. By not having any previous farm experience, small farm operators are in critical need of basic/fundamental information on farming and technical assistance to help get the farm business operation started in the right direction. Modern scientific technology for dairy farming has been difficult to widespread in China, leading to a poor situation in term of feeding and management system. In China, small rural farmers raised over 80% of dairy cattle, plus an incomplete socialized technology service system, modern scientific technologies for feeding (like TMR) and management can be hardly applied. It was the extensive feeding and management system that has limited milk production and use duration of dairy cattle.

1.3.4. Quality milk

The quality of raw milk is un-steady. Quality and safety control system in small farms need to be improved. Especially there are no update standards on raw milk and dairy products, which causes conflicts between small farms and milk processing plants.

1.3.5. Feeding and environmental issue

Small dairy farms are an important part of Chinese agriculture. However, small dairy farms usually can not use the best management practices to protect the environment and help to maintain or improve their own farming investment. They are facing increasing attention about the way they affect the environment. The following pollutants and /or nuisances are commonly found on small farms: manure, eroded soil, bacteria, odor, ammonia, dust, flies, and rodents.

2. Implementing the Codex Alimentarius Code of Practice on Good Animal Feeding and Other Aspects of Primary Production

A.W. Speedy[1], D.A. Battaglia[2]

2.1. Introduction

Milk leaving the farm is expected to be pure, sweet, clean and marketable, to be free of additives and contaminants and to comply with statutory requirements. This has long been the basis of quality standards in developed countries but now many emerging nations are seeking to improve the status and marketability of their milk and dairy products. Failure to do so leaves dairy farmers and the milk industry open to major competition from powdered milk imports, which may be perceived as safer.

To achieve high quality standards depends on good farm management, on the correct feeding of the cows and on milking practice and storage conditions. With a view to improving milk quality and hygiene standards in all countries, the Codex Alimentarius Commission recently published a new Code of Hygienic Practice for Milk and Milk Products (CAC, 2004a), as well as a Code of Practice on Good Animal Feeding (CAC, 2004b).

The Code states: "Because of the important influence of primary production activities on the safety of milk products, potential microbiological contamination from all sources should be minimized to the greatest extent practicable at this phase of production. It is recognized that microbiological hazards can be introduced both from the farm environment and from the milking animals themselves. Appropriate animal husbandry practices should be respected and care should be taken to assure that proper health of the milking animals is maintained. Further, lack of good agricultural, animal feeding and veterinary practices and inadequate general hygiene of milking personnel and equipment and inappropriate milking methods may lead to unacceptable levels of contamination with chemical residues and other contaminants during primary production".

FAO has collaborated with the International Dairy Federation (IDF) Task Force on Good Dairy Farming Practices between 2001 and 2004, culminating in the joint publication of the Guide to Good Dairy Farming Practice (FAO/IDF, 2004). This covers all the aspects of: animal feeding, animal health management, drugs and contaminants residues, microbiological hygiene and environmental contamination.

2.2. FAO and the Codex Alimentarius

The Codex Alimentarius Commission is the intergovernmental body that develops food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this programme are protecting health of the consumers and ensuring fair trade practices in the food trade, and promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations.

The Codex Alimentarius contains General Standards which include: food labelling; food additives; contaminants; methods of analysis and sampling; food hygiene; nutrition and foods for special dietary uses; food import and export inspection and certification systems; residues of veterinary drugs in foods; and pesticide residues in foods.

In addition, Codex contains Standards and Codes relating to specific commodities. Of relevance to the present subject are the two Codes relating to dairying: the **Code of Hygienic Practice for Milk and Milk Products** (CAC, 2004a) and the **Code of Practice on Good Animal Feeding** (CAC, 2004b).

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2.3. The Codex Code of Hygienic Practice for Milk and Milk Products

The purpose of this Code is to provide guidance to ensure the safety and suitability of milk and milk products to protect consumers' health. In the introduction, it is noted that dairy animals may carry human pathogens, which may cause food borne illness. Moreover, the milking procedure, subsequent pooling and the storage of milk carry the risks of further contamination from man or the environment or growth of inherent pathogens. Further, the composition of many milk products makes them good media for the outgrowth of pathogenic microorganisms. Potential also exists for the contamination of milk with residues of veterinary drugs, pesticides and other chemical contaminants. Therefore, implementing the proper hygienic control of milk and milk products throughout the food chain is essential to ensure the safety and suitability of these foods for their intended use. This Code takes into consideration, to the extent possible, the various production and processing procedures as well as the differing characteristics of milk from various milking animals used in different countries. It covers:

- Primary production
- Environmental hygiene
- Hygienic production of milk
- Handling storage and transport
- Record Keeping
- Equipment and facilities
- Control of operation
- Maintenance and sanitation
- Personal hygiene
- Transport
- Processing
- Product information and consumer awareness
- Training

2.3.1. Sources of milk contamination

Microbiological (bacterial) contamination of milk arises from poor milking hygiene, equipment, storage and transport of milk. This subject is dealt with elsewhere in this meeting, but other forms of contamination may arise at other points in the production system or food chain: in particular, contamination of animal feed through accidental (chemical, biological) means or natural contaminants, including mycotoxins and/or pathogens.

2.3.2. Environmental contaminants

A wide range of organic and inorganic compounds may occur in feedstuffs, including pesticides, industrial pollutants, radionuclides and heavy metals. Pesticides that may contaminate feeds include organochlorine, organophosphate and pyrethroid compounds. Although pesticides are potentially toxic to farm livestock, the primary focus of concern centres on residues in animal products destined for human consumption. Dioxins and polychlorinated biphenyls (PCBs) are examples of industrial pollutants that may contaminate feeds, particularly herbage. Cows grazing pastures that are close to industrial areas produce milk with higher dioxin content than cows from rural farms (D'Mello, 2004).

2.3.3. Bacterial contaminants

There has been considerable interest in the occurrence of *Escherichia coli* in animal feeds following the association of the O157 type of these bacteria with human illness. Replication of faecal *E. coli*, including the O157 type, was demonstrated in a variety of feeds under conditions likely to occur on cattle farms in the summer months. Since faecal contamination of feeds is widespread on farms, it is an important route for exposure of cattle to *E. coli* and other organisms (D'Mello, 2004)

Listeria monocytogenes tends to occur in poor-quality silages and big-bale silage. When grass is ensiled under anaerobic conditions, the low pH regime ensures that *Listeria* is excluded from the resulting silage. However, in big-bale silage a degree of aerobic fermentation may occur, raising pH levels and allowing the growth of *Listeria*. These bacteria also survive at low temperatures and in silages with high levels of dry matter. Contamination of silage with *Listeria* is important as it causes abortion, meningitis, encephalitis and septicaemia in animals and humans. The incidence of various forms of listeriosis has been increasing in recent years (D'Mello, 2004).

2.3.4. Mycotoxins

There are consistent reports of worldwide contamination of feeds with fungi and their spores. In the tropics, *Aspergillus* is the predominant genus in dairy and other feeds (Dhand, Joshi and Jand, 1998). Other species include *Penicillium*, *Fusarium* and *Alternaria*, which are also important contaminants of cereal grains (D'Mello, Macdonald and Cochrane, 1993). Fungal contamination is undesirable because of the potential for mycotoxin production. However, spores from mouldy hay, silage, brewers' grain and sugar beet pulp may be inhaled or consumed by animals with deleterious effects termed "mycosis". Common examples of such conditions include ringworm and mycotic abortion. The latter may occur in cattle as a result of systemic transmission and subsequent proliferation in placental and foetal tissues (D'Mello, 2004).

Mycotoxins are those secondary metabolites of fungi that have the capacity to impair animal health and productivity (D'Mello and Macdonald, 1998). The diverse effects precipitated by these compounds are conventionally considered under the generic term "mycotoxicosis", and include distinct syndromes as well as non-specific conditions. Mycotoxin contamination of forages and cereals frequently occurs in the field following infection of plants with particular pathogenic fungi or with symbiotic endophytes. Contamination may also occur during processing and storage of harvested products and feed whenever environmental conditions are appropriate for spoilage fungi. Moisture content and ambient temperature are key determinants of fungal colonization and mycotoxin production. It is conventional to subdivide toxigenic fungi into "field" (or plant-pathogenic) and "storage" (or saprophytic/spoilage) organisms. *Claviceps*, *Neotyphodium*, *Fusarium* and *Alternaria* are classical representatives of field fungi while *Aspergillus* and *Penicillium* exemplify storage organisms. Mycotoxigenic species may be further distinguished on the basis of geographical prevalence, reflecting specific environmental requirements for growth and secondary metabolism. Thus, *Aspergillus flavus, A. parasiticus* and *A. ochraceus* readily proliferate under warm, humid conditions, while *Penicillium expansum* and *P. verrucosum* are essentially temperate fungi. Consequently, the *Aspergillus* mycotoxins predominate in plant products emanating from the tropics and other warm regions, while the *Penicillium* mycotoxins occur widely in temperate foods, particularly cereal grains. *Fusarium* fungi are more ubiquitous, but even this genus contains toxigenic species that are almost exclusively associated with cereals from warm countries (D'Mello, 2004).

The Aflatoxin group includes aflatoxin B1, B2, G1 and G2 (AFB1, AFB2, AFG1 and AFG2, respectively). In addition, aflatoxin M1 (AFM1) has been identified in the milk of dairy cows consuming AFB1-contaminated feeds. The aflatoxigenic Aspergilli are generally regarded as storage fungi, proliferating under conditions of relatively high moisture/humidity and temperature. Aflatoxin contamination is, therefore, almost exclusively confined to tropical feeds such as oilseed by-products derived from groundnuts, cottonseed and palm kernel. Aflatoxin contamination of maize is also an important problem in warm humid regions where *A. flavus* may infect the crop prior to harvest and remain viable during storage (D'Mello, 2004).

Surveillance of animal feeds for aflatoxins is an ongoing issue, owing to their diverse forms of toxicity and also because of legislation in developed countries (D'Mello and Macdonald, 1998). The importance of aflatoxins in animal health emerged in 1960, following an incident in the United Kingdom in which 100 000 turkey poults died from acute necrosis of the liver and hyperplasia of the bile duct ("turkey X disease"), attributed to the consumption of groundnuts infected with *Aspergillus flavus*. This event marked a defining point in the history of mycotoxicoses, leading to the discovery of the aflatoxins. Subsequent studies showed that aflatoxins are acutely toxic to ducklings, but ruminants are more resistant. However, the major impetus arose from epidemiological evidence linking chronic aflatoxin exposure with the incidence of cancer in humans.

Control of mould growth in feeds can be accomplished by keeping moisture low, temperature moderately low, keeping feed fresh, keeping equipments used on-farm clean, and where possible using mould inhibitors. First step in mould control is to ensuring that the food (grains) or feed (crop residues, hay and agro-industrial processing by-products) is dried adequately. The dried grains and feeds (including poultry manure) should then be stored at a well-aerated barn and at low moisture level (14 percent or less) to discourage mould growth. In silages (forage, brewers waste) mycotoxins can be prevented by following accepted ensiling practices aimed at inhibiting quality deterioration primarily through elimination of oxygen. Some silage additives (such as ammonia, propionic acid, microbial cultures, or enzymatic silage) may be beneficial in preventing mycotoxins because they are effective at reducing mould growth. Silage silo size should be matched to herd size to ensure daily removal of silage at a rate faster than deterioration. Feed troughs and barns should be cleaned regularly to prevent contamination of fresh feed. At research level, deliberate efforts should be made to prevent mycotoxin contamination before harvest through crop and forage breeding research. Longer-term solutions would include strengthening nationwide surveillance, increased food and feed inspections to ensure food safety, and local education and assistance to ensure that food grains and animal feeds are harvested correctly, dried completely, and stored properly. Agricultural and public health frontline extension staffs need to demonstrate improved methods of feed utilization to resource-poor farm households and educate them against poor practices that encourage mycotoxin contamination of food and feeds on-farm (D'Mello, 2004).

2.4. The Codex Alimentarius Code of Practice on Good Animal Feeding

This Code aims to establish a feed safety system for food producing animals which covers the whole food chain, taking into account relevant aspects of animal health and the environment in order to minimize risks to the health of consumers. This code applies in addition to the principles of food hygiene already established by the Codex Alimentarius Commission, taking into account the special aspects of animal feeding.

The code covers:

- General principles and requirements with respect to feed ingredients
- Labelling
- Traceability/product tracing and record keeping of feed and feed ingredients.
- Inspection and control procedures
- Health hazards associated with animal feed
- Feed additives and veterinary drugs used in medicated feed
- Feed and feed ingredients
- Undesirable substances
- Production, processing, storage, transport and distribution of feed and feed ingredients
- Premises
- Receiving, storage and transportation
- Personnel training
- Sanitation and pest control
- Equipment performance and maintenance
- Manufacturing controls
- Recalls
- On-farm production and use of feed
- Manufacturing of feed on-farm
- Good animal feeding practice
- Stable feeding and lot/intensive feeding units
- Methods of sampling and analysis

Although the Code does not specifically refer to the use of animal proteins in feed (the use of ruminant meat and bone meal was already banned in most of the countries because of the risk of Bovine Spongiform Encephalopathy), many aspects are vital to the regulation and control of animal feed to enable the enforcement of the feed ban and the prevention of cross contamination to be achieved. This includes labelling, traceability, inspection, production, processing, storage, transport, sampling and analysis and training. It further includes the manufacture of feed on farm when raw materials may be used as opposed to finished feeds produced in a feed mill.

Where not covered in detail in the Code, other aspects are the subject of further Codex standards such as the Codex Committee on General Principles, the Codex Committee on Food Labelling, Codex Committee on Methods of Sampling and Analysis, etc., that provide further guidance to the feed industry on relevant aspects of control and safety.

2.5. Implementation of Animal Feed Regulations: Industry Guidelines

While the Codex Code of Practice contains all the necessary elements for safety assurance in the feed chain, there is a need to add detail and provide comprehensive guidelines for feed suppliers, processors, manufacturers and other stakeholders. Various national and international organizations have already developed codes and guidelines that will be considered here.

Industry guidelines provide specific requirements and procedures from raw materials through processing and manufacture through to distribution and use, including transport and storage. The various elements include:

- Purchase and transport of raw materials
- Delivery and intake
- Feed formulation
- Mixing of feed additives, premixes, veterinary medicinal substances
- Production
- Incorporation of additives into animal feeds
- Weighing
- Grinding
- Mixing
- Pelleting/Heat treatment
- Cooling
- Storage
- Transport of finished product
- Storage at the customer's premises
- Documents and records
- Record keeping
- Documents relative to the manufacturing process and controls
- Registration of compound feedstuffs
- Complaints and product recall

2.5.1. International Feed Industry Federation

The International Feed Industry Federation (IFIF) is an international non-government organization that represents national and regional feed associations and federations and all others involved in the production of compound animal feeds. IFIF membership comprises three groups: National associations; corporate/commercial members (suppliers to the feed trade); and feed-related organisations. It includes the American Feed Industry Association (AFIA), the European Feed Manufacturers Federation (FEFAC), the China Feed Industry Association (CFIA) and the Brazil National Sindicate of the Animal Feed Industry (Sindirações). IFIF has observer status in the Codex Alimentarius and is working closely with FAO in the practical implementation of the Codex Code of Practice on Animal Feeding.

2.5.2. Grain and Feed Trade Association (GAFTA)

GAFTA is an international trade association for grain, feed, rice and pulses with 930 members in 80 countries. It provides standard forms of contract, training and professional development, dispute resolution services, arbitration and mediation, superintendents' and analysts' schemes, as well as information resources, notably the Traders' Manual.

The GAFTA Traders Manual (GTM) provides standards of best practice for all trade operations. The GAFTA Standard for the international grain and feed trade is an all-encompassing system for adoption worldwide to provide safe food and feed materials. It links together the best practice (HACCP-based approach) on transport, storage, loading, discharge, supervision and analysis from farm onwards for combinable crops and dry, moist and liquid animal feed materials.

2.5.3. The International Feed Ingredient Standard (IFIS)

In response to the need for harmonization of assurance schemes throughout the world, the Agricultural Industries Confederation (AIC) has joined forces with three European organisations, Ovocom in Belgium, QS Qualität und Sicherheit in Germany and Productschap Diervoeder in Holland to create the International Feed Safety Alliance (IFSA).

Together with the help of FEFAC the Alliance has developed a single common standard for the quality assurance of feed ingredients. The individual standards, which are currently owned by the four national organisations, will then be replaced by a common standard to be managed by the IFSA.

This International Feed Ingredients Standard (IFIS) (IFSA, 2005) sets out the requirements for supplier companies participating in the International Feed Ingredients Programme (IFIP). Those companies that successfully achieve certification of compliance with the requirements of the IFIS will be accepted as assured sources for the supply of feed ingredients into feed businesses assured under the Belgian GMP programme, the British UFAS programme, the Dutch GMP+ programme and the German QS programme. The International Feed Ingredients Programme is available to the feed industries of all countries and AIC, FEFAC, OVOCOM, PDV and Q&S welcome participation in the programme by feed industry organisations around the Globe.

2.6. Towards internationally agreed guidelines for animal feed

Given the plethora of Guidelines and Standards, as well as the Codex Code of Practice for Good Animal Feeding, the role of FAO is to attempt to coordinate international efforts into internationally agreed actions, which are both practical and effective. To make them applicable in different countries requires that the principles are risk-based and appropriate to the occurrence and levels of risk in different situations. Much of the following text is based on the work of Dr Steve Hathaway of the New Zealand Food Safety Authority, written as the introductory chapter for the FAO Manual of Good Practices for the Meat Industry (FAO, 2004), adapted in the context of animal feeding and primary production of livestock.

2.6.1. Implementing a Risk Based Approach

The risk based approach to food hygiene has been instituted by both national governments and standard-setting bodies for food in international trade largely as a consequence of the international trade provisions of the WTO Sanitary and Phitosanitary (SPS) Agreement, and as an obligation to justify needed food hygiene measures using science and risk assessment.

The practical application of a risk-based approach requires an understanding of the "building blocks" of a food safety programme (GAP, GMP, GHP, HACCP and risk assessment):

- GAP, GMP and GHP generally consists of a qualitative description of all practices regarding the conditions and measures necessary to ensure the safety and suitability of food requirements. The requirements are generally prescriptive and describe processes rather than outcomes.

- HACCP identifies, evaluates, and controls hazards, which are significant for food safety. The system has designated critical control points at particular steps in the food chain, which may be based on empirical scientific judgement, or on risk assessment.
- A risk assessment programme entails knowledge of the level of control of hazards that is attained at a particular step in the food chain relative to the expected level of consumer protection. The control points are science- and risk-based regulatory limits, which may either be performance criteria (e.g. allowable levels microbial contamination, maximum residue limits, zero tolerance for Transmissible Spongiform Encephalopathies or process criteria (e.g. specified time, temperature or dose at a specified process control step).

The different roles of industry, government and other stakeholders in the design and implementation of a meat hygiene programme, e.g.:

- The competent authority should facilitate application all components of the generic framework for managing risks, set risk-based regulatory requirements as appropriate, and verify that these are being met on an on-going basis.
- The industry should be involved in contributing to risk management decisions, implementing food hygiene programmes, and ensuring compliance with regulatory requirements.

To date, application of risk management principles in the livestock industry has primarily focused on primary production and process control activities. Simulation modelling of risk management interventions in these areas is available for some hazard /product combinations, (e.g. *Campylobacter* and *Salmonella* risk assessment models for broiler chickens; models for *E. coli* species in beef products; and *Listeria monocytogenes* in ready-to-eat- foods) but examples of regulatory uptake of outcomes are rare. The limited application of risk assessment models to other areas of food hygiene to date means that few recommendations on risk-based interventions are available for these activities.

The Codex principles embodied in the Code of Practice for Good Animal Feeding, as well as the Code of Hygienic Practice for Milk and Milk Products stress that any risk-based measures that are employed should be matched to the local or national situation.

2.7. FAO action to implement the Code

FAO is working together with the International Feed Industry Federation to develop the practical implementation of the Code of Practice on Good Animal Feeding through a project supported by the WTO Standards and Trade Development Facility. The objective of the project is to help ensure the safety of food for human consumption through the development and implementation of good animal feeding practice at the farm level (GAPs) and good manufacturing practices (GMPs) during the procurement, handling, storage, processing and distribution of animal feed and feed ingredients for food-producing animals. This will be achieved through the production of manuals and guidelines, through workshops and conferences, and through national and regional training programmes.

A series of manuals and guidelines will focus on elaborating the general principles and specific requirements for: the production, storage and distribution of feed and feed ingredients; employment of risk analysis methodology consistent with internationally accepted practices; management of health hazards associated with animal feed, including feed additives and veterinary drugs used in medicated feed; control measures to avoid unacceptable levels of undesirable substances in feed and feed ingredients; the role of GAPs, GMPs, and HACCP, to control hazards that may occur in feed; traceability and record-keeping of feed and feed ingredients; inspection and control procedures; methods of analysis and sampling based on Codex sampling plans and methods elaborated by international organizations (ISO and/or AOAC International, and conducted in official or officially accredited laboratories that employ Good Laboratory Practices); guidance in respect of the manufacture and use of feed on farm; good animal feeding practice, including pasture grazing, distribution, feeding, stable feeding and intensive feeding; specific conditions applicable to emergency situations.

A series of workshops and conferences have been held to promote the dissemination of information and acceptance of the Code and the elaborated guidelines. Training programmes will be undertaken to develop national and regional capacity for safe feed production and utilization.

2.7.1. Relevance to developing countries

Standards are seen as difficult to apply in 'developing countries' leading to market exclusions for small producers and there is international pressure to give small producers in developing countries 'access to markets'. To address these issues, FAO is concerned to promote the harmonization of standards (based on the Codex Code) and simplification based on the principle of Appropriate Level of Protection (ALOP).

In considering these arguments, it is important to recognize that the term 'developing countries' includes major actors in the field of international trade in feed ingredients and livestock products, such as Brazil, China, India, Thailand and others. It is in the interests of these countries, and greatly to their economic benefit, to participate in the setting and adoption of agreed standards and guidelines.

Even in countries that are not significantly involved in trade, national food safety must be recognized as a vital component of food security and public health. However, it is recognized that the implementation of standards, which require national capacity in human resources, laboratories and equipment, will require international assistance and support through capacity building programmes.

2.7.2. The importance of GAP and GHP

While the application of HACCP is seen as the basis for implementation of food and feed safety programmes, it should be recognized that GAP and GHP are prerequisites to the HACCP programme. As stated in the Codex General Principles of Food Hygiene (CAC, 2003), in implementing an HACCP system in an establishment, the first step is to review existing programmes for compliance with the General Principles of Food Hygiene and GMPs and to verify whether all the necessary controls and documentation (e.g. programme description, individual responsible and monitoring records) are in place.

The Codex guidelines on HACCP define a critical control point (CCP) as "a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level".

The importance of GAP and GHP cannot be overstated, as they are the foundation of the implementation of the HACCP plan. Adherence to the General Principles of Food Hygiene and GMPs will simplify the implementation of HACCP plans and will ensure that the integrity of HACCP plans is maintained and that the product is safe.

In particular, FAO is promoting the adoption of Good Agricultural Practices (GAP) to ensure the safety of the primary production process including animal feed and feeding. GAP processes for decision-taking at the farm-level has been increasingly recognized as the essential prerequisite to food safety from farm to fork. FAO has focused on the principles and proposed the way forward through a process to:

- Formulate a set of generic practices and indicators from which guidelines for good agricultural practices for on-farm production post-production systems can be developed, collaboratively by the public and private sectors and civil society.
- Focus existing knowledge, options, and solutions into effective food safety and environmental risk analysis guidelines available for use as policy instruments.
- Review existing codes of practice.
- Translate codes of practice into management guidelines for crop and livestock systems in specific agro-ecozones.
- Engage in discussion with governments on their strategies, priorities and instruments to move towards sustainable agriculture and rural development practices.

This approach is supported by the FAO Committee on Agriculture (COAG) and is seen to build on the existing activities in this area by governments, civil society, non-governmental organizations, the private sector and international partners but emphasized that a GAP approach should not create new barriers to trade and thus undermine poverty alleviation efforts, but be consistent with the existing regulatory instruments, such as Codex, IPPC and OIE.

2.7.3. Good Agricultural Practices at Farm Level

Many of the principles of Good Agricultural Practices related to livestock production and feeding are common sense and may be readily applied in all countries. Thus, it is noted that livestock require adequate space, feed and water to ensure animal welfare and productivity. Record keeping of livestock and of breeding programmes will ensure traceability of type and origin. Stocking rates are adjusted and supplements provided as needed to livestock grazing pasture or rangeland. Chemical and biological contaminants in livestock feeds are avoided to prevent their entry into the food chain. Manure management avoids nutrient losses, minimizes negative, and stimulates positive effects on the environment. Land requirements of livestock production are evaluated to ensure sufficient land for feed production and waste disposal.

Successful animal production also requires attention to animal health. The health of livestock is maintained by proper management and housing, by preventive treatments such as vaccination and by regular inspection, identification, and treatment of ailments, using veterinary advice as required.

In terms of feed ingredient production, crops, cultivars and varieties should be chosen for their suitability to the site and their role within the crop rotation for the management of soil fertility, pests and diseases, available inputs, and local consumer and market needs. Perennial crops are used to provide long-term production options and opportunities for intercropping. Annual crops are grown in sequence, including those with pasture, to maximize the biological benefits of interactions between species and to maintain productivity. Rangelands are managed to maintain plant cover, productivity and species diversity. Harvesting of all crop and animal products removes their nutrient content from the site and must ultimately be replaced to maintain long-term productivity.

2.8. Conclusions

The paper reviews the Codex Code of Practice on Good Animal Feeding as well as a range of international and industry based schemes for implementation of the principles of food and feed safety. Although there are many standards and schemes, these can be brought together to provide international guidelines for food and feed safety. In particular, food safety programmes should be risk based, including risk assessment, risk management and risk communication. Codex principles of risk analysis stress the importance of achieving the Appropriate Level of Protection on a national basis.

It is in the interests of countries and to their economic benefit to participate in the setting and adoption of agreed standards and guidelines. National food safety must be recognized as a vital component of food security and public health. But the implementation of standards, which require national capacity in human resources, laboratories and equipment, will require international assistance and support through capacity building programmes.

Finally, the potential to simplify HACCP programmes by the effective implementation of General Principles of Food Hygiene, Good Manufacturing Practices and especially Good Agricultural Practices at farm level is seen as a guiding principle to effective implementation of Good Animal Feeding in all countries.

Working with the International Feed Industry Federation in a project supported by the WTO Standards and Trade Development Facility, these principles will shortly be translated into a Guide to Good Practices for the Feed Industry, leading to effective implementation of the Codex Code of Practice on Good Animal Feeding.

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3. Nutritional approaches relevant to dairy animals in India

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Abstract

India aims at producing 172 MMT milk by the end of 2022, at an annual growth rate of 4 per cent. As there is shortage of feed and fodder resources in the country, available feed resources would need to be utilized judiciously and with value addition. Farmers therefore need to be encouraged to adopt improved and balanced feeding practices so that they could improve yields with available feed resources in a cost effective manner.

Although crop residues are abundantly available in India and form the bulk of basal diet of large ruminants, they are not evenly distributed across the country. In addition, their nutritive value is low. Therefore, use of strategic supplements in diet and technologies for enrichment and densification of crop residues needs to be encouraged. While strategic supplements help in efficient utilization of crop residues, enrichment and densification technologies help in improved nutritive value and reduced cost of transportation/storage, respectively.

As mineral deficiencies in animal rations varies with agro climatic conditions, mapping of such deficiencies needs to be done across such identifiable zones, to develop area specific mineral mixtures for supplementing the ration of animals for improved growth, milk production and reproduction efficiency.

Feeding animals with compound feeds can improve utilization efficiency of the concentrate feeds available in limited quantity. The type of compound feed to be promoted in a particular zone would depend on availability of basal feeds, milk production potential of milch animals and the level of milk production in that zone. Utilization efficiency of protein meals could be improved if they are subjected to suitable chemical treatment by a process known as bypass protein technology, in which the proportion of proteins degraded by rumen microorganism is reduced, thereby increasing its availability to the animal. Production of bypass protein meals needs to be scaled to commercial levels for improved growth and production.

Green fodder production need to be increased from the available cultivated land, by making available certified fodder seeds to farmers in time. In addition, wastelands through watershed management need to be developed for green fodder production, so that the gap between the requirement and the availability could be minimized. With the large-scale implementations of the above-mentioned technological innovations, it may be possible to produce milk in India at the desired level.

3.1. Introduction

The current level of milk production level by various species of animals suggests that the genetic potential of the animals for milk production is not fully exploited, due to shortage of feed resources and imbalanced feeding. Milk production targets could be achieved if the available feed resources are utilized efficiently and genetic potential of animals for milk production is realized to the maximum possible extent.

Some of the interventions in the area of feeding and its management that could be implemented under Indian conditions include, a) ration balancing programmes at farmer's level with the available feed resources, by using a computer package in regional languages; b) enrichment and densification of crop residues; c) bypass protein technology; d) use of urea molasses mineral block licks as supplement to straw based diet; e) use of area specific mineral mixtures in the ration; f) production and use of different types of compound cattle feed; g) to improve green fodder production from the cultivable land and h) use of wastelands for green fodder production.

Work has already been initiated on commercial lines in India, on the above- mentioned technologies, by the National Dairy Development Board (NDDB) of India and other organizations

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and the results are quite encouraging. It is expected that with the large-scale use of these technologies, it should be possible to achieve milk production target with the available feeds and fodder resources.

3.2. Livestock population and dairy husbandry in India

India is bestowed with a huge livestock population comprising 222 million cattle, 98 million buffaloes, 124 million goats, 61 million sheep and 489 million poultry [1]. Animal Husbandry, Dairy and Fisheries sub-sectors generate supplementary incomes and gainful employment for rural households, particularly among landless, marginal or small farmers, as well as women. The products of these sub-sectors are also a source of valuable nutrients to millions of people in India. Dairying in India has emerged as an important sub-sector accounting for nearly two thirds of the total livestock contribution to GDP with an encouraging growth rate of 5 per cent. Agriculture and allied sectors account for about 24% of GDP. Of this, animal husbandry and dairy accounts for about 25%. Unlike many developed dairying countries where large mechanized farms managed by very few farm households is predominant, more than 70 million rural families are engaged in milk production in India. Landless, small and marginal farmers with limited resources account for 65% of the total milk production in the country.

Dairy cattle production is mostly based on crop residues such as straws, stovers and agro-industrial byproducts, which need supplementation through energy and protein rich concentrates in the form of coarse grains, oil meals and cereal *brans*.

Crop residues are abundantly available in India and there is apparently no competition for these resources between other species and dairy animals. Dairy animals convert these crops residues, which otherwise have limited economic value, into a nutritious food in the form of milk. . Over the years, there has been a perceptible change in total livestock population and their composition. The milch buffaloes and crossbred cattle population has been increasing gradually, while the male population of cattle and buffaloes have been decreasing due to mechanization in agriculture and shortage of feed resources for feeding unproductive animals.

3.3. Status of feed resources

Feed resources can be broadly categorized into dry fodder (crop residues), green fodder and concentrates. Crop residues include wheat, paddy, sorghum and millet straws, *kadbies* etc., green fodder include cultivated legumes and non-legumes, pastures, sugarcane tops etc. and concentrates include grains, oil cakes/meals, *brans, chunnies*, agro-industrial byproducts.

The availability of feed resources has been calculated using appropriate grain to straw ratios for crop residues, extraction rates for concentrates and average green biomass production potential of different categories of land. The total potential availability of feed resources for the year 2005-06 works out to 47 million tones of concentrates, 495 million tones of crop residues and 511 million tones of green fodder. The requirement for the year 2005-06 works out to 83 million tones of concentrates, 432 million tones of crop residues and 734 million tones of green fodder, indicating a huge shortage of concentrates and green fodder [2].

To minimize the gap between requirement and availability of feed resources, some of the technologies that could be used in utilizing feed resources judiciously with value addition, are briefly described below.

3.4. Implementation of the ration-balancing programme

Implementation of ration balancing programme at farmers' doorstep is very important, as animals are often fed on locally available feed resources which are either low in protein or energy. This results in imbalanced feeding of nutrients due to which the animals do not produce at optimum levels and/or the cost of feeding is more.

In India, only 10 per cent of total feed ingredients are fed in the form of compounded cattle feed. The rest of the locally available or homegrown feed ingredients are fed as such to their animals by the farmers. Some farmers are feeding only *brans*, grains or cakes to their animals.

These ingredients are rich in one or two nutrients. *Brans* for example, are rich in phosphorus but low in calcium. Animals respond better in terms of growth and milk production, with more or less similar or lower input cost, when they are fed with feed ingredients and other agro-industrial byproducts that are mixed in right proportion and fortified with small quantity of minerals and vitamins,

NDDB is supporting a ration balancing programme, under which farmers are advised to feed their animals a balanced ration that is determined by a computer based least cost computation, and which takes into account the animal's requirement of nutrients for existing physiological functions and the nutrient available to the animal from the prevailing feeding practices. For the implementation of ration balancing programme, NDDB has developed a computer software, which can be used under field conditions by a village based resource person.

3.5. Enrichment and densification of crop residues

Availability of crop residues is uneven, with some areas having a surplus and others facing a perennial shortage of dry fodder. Regional imbalances and shortages of crop residues lead to a) sub-optimal livestock productivity due to imbalanced feeding and b) significant costs on account of transporting low bulk density residues across large distances. Loss in productivity is irreversible at times and the net profitability of livestock owners is greatly affected due to this phenomenon, thus, there is a need to manage feed and fodder resources efficiently during this period, with value addition [3]. Mature forages/crop residues are often regarded as survival feeds and are fed without supplements. This is a major mistake as most of the crop residues can only be used efficiently with appropriate supplements for maintenance and/or production. Periods of survival feeding of imbalanced diets during scarcity/drought may depress future productivity.

Even though crop residues are sold at a premium (Rs 4 per kg and more) in deficit and drought prone regions, they are often burnt in surplus areas. Crop residues that are enriched and densified in the form of blocks, pellets, briquettes etc. can be transported at lower cost from the surplus to deficit regions. Some of the existing infrastructure can be utilized for the production of straw based pellets, briquettes etc., without any additional investment.

Wheat straw is transported to Rajasthan from different parts of Punjab, Haryana and Uttar Pradesh. In Kerala, rice straw is transported from Tamil Nadu, Karnataka and Andhra Pradesh. Similarly, crop residues are transported in some parts of Maharashtra and Western Gujarat during droughts [3]. If crop residues are enriched with molasses and urea and then densified in the form of blocks, briquettes or pellets, then it is possible to increase bulk density of crop residues. Such value addition could not only increase the nutritive value and palatability of crop residues, but also save storage space and reduce transport cost and wastage. A few plants have been set up in fodder surplus areas which produce enriched and densified feed blocks, for use in deficit areas.

3.5.1. Straw based pellets

Wheat straw and other lignified straws are easier to crush since they are harder. Although, wheat straw is preferred in some geographical regions, it is traditionally not used for feeding ruminants in some parts of the country. Straw-based pellets in limited quantity produced by NDDB were field-tested successfully in a drought-affected area. While pelleting can densify straw to a high degree, it is an energy intense process involving chopping and grinding of straws. The composition of straw-based pellets is: wheat straw 40%, deoiled rice bran 37%, mineral mixture 1.0%, common salt 1.0%, rice polish fine 5.0%, urea 1.0% and molasses 15.0%.

These pellets contain 10 per cent crude protein and 8.00 MJ/kg ME value and were found to be palatable when fed to animals. Efforts are being made to propagate use of these pellets made using flat die on commercial scale in wheat straw surplus area, so that the same could be used in a fodder deficit area, especially during scarcity/drought.

3.5.2. Straw based blocks

Straw based block manufacturing technology is suitable for handling all types of crop residues. The composition of enriched straw blocks is: straw 64.0%, deoiled rice bran 20%, urea 1% and molasses 15.0%.

The enriched straw based blocks contain about 8-10 per cent crude protein and 8.00 MJ/kg ME value. This can help in not only saving the transportation cost and storage space but also improve the nutritive value and palatability of straws and reduce wastage. The composition of the straw based blocks could be adjusted, depending upon the level of productivity of animals.

3.5.3. Straw based briquettes

Straw based briquettes comprising deoiled rice bran (DORB) and wheat straw (50:50), deoiled rice bran and paddy straw (40:60) were prepared and analyzed. The chemical composition of the straw-based briquettes indicates that the cell wall constituents of the straws are not affected by briquetting. There is no increase in content of Neutral Detergent Insoluble Nitrogen (NDIN) and Acid Detergent Insoluble Nitrogen (ADIN). The briquetting process through application of pressure and heat densifies the straws by 10-12 times [4].

3.6. Urea molasses mineral block (UMMB) as a supplement

Crop residues are deficient in fermentable nitrogen and minerals. In absence of adequate quantity of green fodder in the diet, rumen microbes don't get nutrients supply for their own growth [5]. As a result, digestibility of fibrous feed in the rumen is affected. Urea molasses mineral block helps in improving the utilization of dry fodder, especially when green fodder availability is a constraint [6]. Farmers could use UMMB supplement as economical source of deficient nutrients, when their animals are fed on straw based diet.

Benefits of feeding UMMB:

- Improves intake of crop residues, straws, kadbies etc resulting in reduced wastage.
- Improves digestive efficiency of dry fodder, which helps in improving milk production.
- Increases the fat content in milk through improving the digestibility of dry fodder.
- Urea molasses mineral block is also an important source of minerals.
- Urea molasses mineral block supplement, along with dry fodder can meet the maintenance requirement of animals, especially during natural calamities.

NDDB has developed 'Cold Process' of manufacturing UMMB and designed a simple device for manufacturing block licks. UMMB lick contains urea, molasses, mineral, brans/cakes, common salt and phosphate supplement, which provides optimum quantities of fermentable nitrogen, energy and minerals for growth of rumen microorganisms [7], which ultimately lead to efficient utilization of crop residues [8].

Currently, 12 plants set up by NDDB on behalf of dairy cooperatives are producing about 3 00 000 UMMB licks of three kg each per annum, in different parts of the country. UMMB supplementation in the diet of ruminant animals helps in improving the feed intake, rumen fermentation, growth and milk production [9]. Even though several farmers have started using UMMB licks for their animals, particularly in drought prone areas [8], extension efforts are required to popularize this product.

3.7. Supplementation of area specific mineral mixtures

Supplementation of minerals helps in efficient utilization of absorbed nutrients and many other ways, for improving growth, milk production and reproduction efficiency.

In India, feeding of animals is traditional in nature and much depends upon locally available feed resources. Crop residues based basal diet is poor in essential minerals. It also contains several anti-nutritional factors like silicates, oxalates and phytic acid, which further inhibit their utilization [10]. As animals do not synthesize minerals, their supplementation through mineral mixture is of paramount importance.

Benefits of feeding mineral mixture to animals:

- Improves growth rate in young calves.
- Improves efficiency of feed utilization.
- Improves milk production.
- Better reproduction efficiency and reduces inter-calving period.
- Helps increasing productive life of animals.
- Improves resistance against infectious diseases.
- Helps minimizing the incidence of certain metabolic diseases.

As mineral deficiencies in the ration of animals varies with agro climatic conditions, mapping of such deficiencies are being undertaken across different zones under different States to help develop area specific mineral mixtures for supplementing the ration of animals in effective and economical manner.

A survey work conducted by the NDDB in Gujarat, Rajasthan, Kerala and Punjab States, indicated that zinc, copper, sulphur, manganese, cobalt are deficient in the ration of animals [11]. While the levels of calcium, phosphorus and sodium were found to be deficient, the levels of magnesium, potassium, iron and selenium were adequate in the diet of lactating animals. Based on survey work, mineral mixtures have been formulated for the States of Gujarat, Rajasthan and Kerala, incorporating deficient minerals and excluding excess minerals in the total ration of animals. Similar work on mineral status of dairy animals [12] is being undertaken in India by other institutes as well. With NDDB's assistance, fourteen mineral mixture plants have been set up by the cooperative sector, in the States of Gujarat, Rajasthan, Kerala, Punjab, Haryana, Maharashtra, Karnataka and Andhra Pradesh [13].

3.8. Bypass protein supplement as a top feed

As the availability of protein meals in the country is limited, chemical treatment can help increase their efficiency of utilization. Against the current requirement of about 25 MMT of protein meals for feeding dairy animals, only 18 MMT protein meals are available. When these meals are fed as such to ruminants, about 70% of the protein is broken to ammonia in the rumen and a significant portion of it is excreted in the form of urea through urine. However, if these meals are subjected to suitable chemical treatment- termed as "bypass protein technology", then their efficiency of utilization can be significantly improved. While the cost of treatment of protein meals is less than a rupee per kg, feeding one kg of treated meal can help increase milk production by more than a litre as compared to untreated meal [14]. As almost all types of meals are suitable for bypass protein technology, locally available meals could be used in different regions. Treated protein meals can be fed to animals, either as top feeds or by incorporating them in cattle feed @ 25%. Two commercial bypass protein plants for treating protein meals have been set up in the State of Gujarat, India. Treated protein meals were tried on cows and buffaloes by NDDB, Anand, National Dairy Research Institute, Karnal [15] and Orissa Veterinary College, Bhubaneshwar. In all the feeding trials, feeding 1 kg of bypass protein supplement increased daily milk yield, fat and protein per cent by 0.8-1.2 litre, 0.2-0.5% and 0.2-0.3%, respectively, as compared to untreated meal [3]. The net daily income increased by Rs.9-10 per animal in animals yielding 8-10 litres milk and Rs.5-6 per animal in low yielding animals (3-4 litres per day).

A major issue that appears to have gone largely unrecognized is the carryover effect on future productivity due to bypass protein supplementation to young and lactating animals. If animals are supplemented with a source of bypass protein during drought then they are able to maintain milk production and there is minimum damage to future productivity. Replacement heifers and growing calves could be fed limited quantity of bypass protein supplement, to exploit their genetic potential for milk production.

Benefits of bypass protein feeding:

- Higher availability of amino acids per unit of feed.
- Better utilization of protein meals having higher rumen protein degradability.
- Judicious utilization of protein meals, available in limited quantity.
- Improves growth & milk production (0.8-1.2 litre/day).
- Improves protein % (0.1-0.3%) in milk, hence, improves SNF content of milk.
- Improves fat % (0.2-0.8%) in milk.
- Better economic returns, for same input cost.
- Useful for low and high yielding animals, relevant to Indian conditions of feeding and management.

3.9. Compound cattle feed as a source of balanced nutrients

Farmers generally feed their animals one or two locally available concentrate ingredients. The quantities fed are generally based on the level of milk production, without considering the animal's total requirement of nutrients. This type of diet is not always able to meet protein, energy, minerals and vitamins requirement of animals. As a result, animals do not produce milk as per their genetic potential and the cost of milk production is high on account of imbalanced feeding [16].

Different feed ingredients are rich in different nutrients. It is therefore important that different feed ingredients such as grains, *brans*, protein meals/cakes, *chunnies*, agro-industrial byproducts, minerals and vitamins are mixed in suitable proportion to make compound feed. The relative proportion of individual ingredients should be based on the milk production potential of animals and the composition of the basal diet. When compound feed is fed along with the basal diet, nutrient requirement of animals can be met more efficiently and economically [8]. The composition of compound cattle feed should vary in accordance with the animal type, season, region etc., and should be able to meet requirement of animals in order to optimize milk production, with minimum input cost.

3.10. Improved green fodder yield from the available land under fodder production

As limited land is available for green fodder production, fodder yield per hectare need to be improved. At present, 9.38 million hectare of area is under fodder cultivation and less than 5% of this area is covered under improved fodder seeds for green fodder production. Efforts are being made to produce and supply certified fodder seeds to farmers, to cover at least 10% of the total area under fodder production. This would increase the green fodder production per hectare of land. In addition, efforts are being made to develop wasteland through watershed management for green fodder production, so that the gap between the requirement and the availability could be minimized.

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4. Milk Hygiene on the Farm. Experiences of Asia Development Bank and NZAID Projects on Milk Hygiene Practices in China's Guizhou Province

T.G. Harvey[1], J. Xie[2]

Abstract

Poor milk hygiene standards in village based dairy systems in south-west China (Guizhou Province) were putting the health of some children at risk. The challenge for UNDP, China and NZAID projects was to determine if milk quality and hygiene standards could be improved, through the introduction of "Best on Farm Practice" for village farmers and small scale milk processing plants.

The 1989-1994 UNDP/NZ Project and 1999 The Developing Natural Grassland Demonstrational Project in South China (Dushan 1999) introduced pasture based dairy production systems to Guizhou. It became evident at the start of the project that on farm hygiene standards were well below international standards and milk delivered to small scale processing plants was unsafe. Milk rejection rates were high, testing methods at collection stations were inadequate and, the local technicians lacked knowledge and technical skills.

In 2001 a participatory NZAID development programme was started to develop a set of "Best on Farm Practice" for milk hygiene. A targeted training manual was created for use in rural households involved with milk production and for small scale processing plants. The project was supported by the Guizhou Department of Animal Husbandry, which coordinated a 12 month training project in the areas surrounding three processing plants in Guizhou.

The project had a marked effect on milk quality, reducing the level of mastitis from over 46% to 12%. Milk rejection rates were reduced from 11% to less than 1%. Antibiotic use was reduced through the implementation of good farm management practices. The shelf life of pasteurised fresh milk was extended through the introduction of Hazard Analysis Critical Control Point (HACCP) and red line methodology. A number of the smallest processing plants closed or amalgamated due to the high compliance cost of introducing best practice. Project farmers' income's increased and the number of rural families involved in dairy increased from five to over 350 in one of the three project sites.

4.1. Introduction

Village based dairy production based on pasture production has been increasing over the last 10 years in Guizhou and Southwest China. However, the local farmers and small Milk Processing Centres have faced some real challenges as the industry has developed. The key questions that have faced this dairy industry are:

- Can small village based dairy farms remain economic and sustainable in the future?

and

- Can small Milk Processing Centres remain profitable and produce safe, quality milk products to international standards in a hygienic environment?

Figure 1: Village Based Dairy Farming

These are the questions that a range of UNDP, China Government and NZAID development projects have tackled over the last 10 years in Guizhou. Modern dairy industries all over the world have a common objective; to produce high quality foods, which are suitable from hu-

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mans, from animal feedstuffs, which are not suitable for humans. [1]

A group of NZ and Chinese consultants and researchers from Massey University have been working in Guizhou for over 20 years developing pasture based farms. As part of this relationship a demonstration pastoral farm has been set up and developed at the Dushan Demonstration Seed farm near Dushan [2]. Over the last 10 years the focus of these projects has been to build village based dairy production systems. This has resulted in significant growth and there are now approximately 500 village based dairy farms in the provinces.

Figure 2: Pastoral Farming Dushan

The development projects soon concluded that small village based dairy farms could be profitable and lift farmer incomes. However, there were major risks as a high percentage of the milk produced was well below international standards for liquid milk consumption. A 3-year Milk Hygiene project was undertaken through NZAID and the Department of Agriculture in Guizhou to target Milk Hygiene at the farmer level. [3] The low hygiene and farm management standards affected the profitability of the farms as well as putting children and the elderly (the main consumer of fresh milk) at considerable risk of food poisoning.

The project also identified that small stand alone Milk Processing Centres were often poorly managed and had little understanding of modern hygiene compliance requirements. Many of these very small (500-5000kg milk per day) Milk Processing Centres were also non-sustainable, unprofitable, lacked expertise and have had a very short economic life. High compliance costs and low economies of scale made some of these small processing units uneconomic and a liability in regard to the Food Health Standards. These issues raised the question of what is an appropriate size for Milk Processing Centres, and how to make these small processing centres profitable and sustainable while meeting international standards.

Figure 3: Pre Project Milk Pasteurization

4.2. NZ Experience

New Zealand's experience over the last 100 years can provide some valuable information about the sustainability of Milk Processing Centres and family based dairy farming. In 1940 NZ had approximately 560 milk processing companies, 63 000 dairy farmers with an average herd of 26 cows. By 1970 there were 156 processing companies, 21 900 farmers with and average herd size of 94; in 2000 NZ had only 5 major dairy companies processing, 12 million tones of milk pa; 14 000 dairy farmers with an average herd of 300 cows. [4]

Figure 4: New Zealand Early Milk Processing Centre

As the NZ dairy industry was developing, the small Milk Processing Centres played an important role in the development of the NZ dairy industry. [5] The small Milk Processing Centres close to the farmers were essential until roading, on-farm refrigeration and infrastructure were developed to allow effective road transport of milk by larger tankers. The small Milk Processing Centres also provided technical advice directly to the farmers, as they delivered milk. Farmers got information on milk quality, hygiene regulations and animal health regulations. [6]

Figure 5: New Zealand Milk Transport

A similar trend is likely to be experienced in Southwest China. As roading improves, herd sizes increase and larger sustainable community dairy farm groups develop. The number of smaller Milk Processing Centres will decline and larger centrally based Milk Processing Centres will be developed, collecting milk from a 50km or greater radius. These Milk Processing Centres will need to be linked into larger milk marketing companies with a national and global focus.

4.3. Project Methodology

The first phase of the NZAID Milk Hygiene project was to undertake the development of a training manual that set out "Best On-Farm Practice" for village based dairy production in Southwest China. The training manual was developed as a practical Code of Practice and identified key standards and on-farm procedures required for the production of quality milk.

The second phase was to develop a basic set of standards for small community based Milk Processing Centres. This also gave them a "Code of Practice" to work with.

The "Best On-Farm" concept was totally new to most of the village farmers who were used to a "total regulation" approach being applied by industry officials. The idea of self assessment through a "Code of Practice" was new to them.

Village based dairy farms in this study range in size from 5-25 cows. Ownership is mainly family based and the success of these small farms relies on a range of components and infrastructure coming together in their community.

The on-farm hygiene standards at the start of the project were very low on most of the existing village based dairy farms. Farmers and family members had very little understanding of how to produce quality milk to international standards. Testing of milk was primitive and there was little "feedback" to let farmers know that there were hygiene problems. Lack of clean hot water meant that milk containers and equipment carried large amounts of bacteria.

The project launched a major training and education programme immediately, which developed the "Code of Practice". It introduced mastitis testing using RMT at the farmer level, as well as at the Milk Processing Centres.[7] The educational programme was targeted at all family members and the local animal husbandry technicians. The objective was to lift the overall understanding of each of the communities around the project sites. The overall focus was how to develop a safe and sustainable dairy industry that lifted farmer incomes substantially in these poor rural areas.


Figure 6: Farmer Hygiene Training

The educational programme stressed that there were a number of components needed to lift the standards, these focused on:

- a good base of family labour
- a level of education and farming experience to support a quality based operation
- good government and institutional support
- access to good technical advise
- adequate access to capital
- adequate land for pasture/crop
- roading and transport infrastructure
- milk collection and processing centres close to the village

Farmer and Technician training focused on ensuring farms had:

- a herd of healthy cows
- a clean and tidy animal and milking area
- a healthy team of people to milk the cows
- good milking procedures, and clean milking equipment and containers
- good milk containers and transport to the processing centre
- milk testing procedures that help to identify problem areas
- a profitable and stable outlet market for their milk

4.4. Development of the Code of Practice

The "Best On-Farm Practice – Code of Practice Technical Manual was developed through a consultative process, involving farmers, animal husbandry and food hygiene technicians, at the provincial, county and township level. The technical manual was written in two parts; the first part focused on the farmers' requirements; the second part was focused on the Milk Processing Centres and the Milk Collection Centres operations. [8]

4.4.1. Code of Practice Part I

4.4.1.1 Village Based Dairy Operation

The Best On-Farm Practice manual covered the very practical aspects of the farming operation ensuring farmers understood the importance of each of the different facets of dairy production, as well as giving them a set of standards to follow.

The practical standards introduced were:

Animal Housing and Dairy Equipment - The dairy shed/room should provide adequate shelter from the weather with a high air flow.

Dairy Shed Floors - All floors and yards should be made of concrete and uniformly graded with enough fall to allow easy cleaning and drainage. Floors should be grooved in cow area to reduce slipping.


Figure 7: Pre Project Hygiene Standards

Effluent Disposal - The effluent tank collecting livestock and the farm house effluent discharge should be no closer than 5 metres from the dairy or milking shed. Shed waste (e.g. straw from the floor) should be stored at least 3 metres clear of the shed.

Poultry & Other Livestock - No pigs are to be housed in the cow shed and should be kept at least 10 metres from the dairy. Poultry must not be allowed access to areas where milk and milking equipment is stored.


Figure 8: Pre-Project Milk Transport Container Washing

Water Quality and Supply – the farm should have a supply of running cold water free of sediment and organic matter with as few bacteria as possible. If water quality is low 140 ppm of chlorine should be add to all water used to wash milk equipment. Hoses in the milking area shall be kept off the floor. Hoses ends shall be fitted with plastic hose rings 75mm round to reduce bacteria contaminants. All milking and milk transport equipment is to be washed in hot water using an alkaline and acid detergent programme.

Milking Buckets and Milk Machines – Buckets and milk machines should be made of stainless steel. Stainless steel buckets should have no seams or rivets and all equipment should be cleaned and sanitized immediately after use with hot water and an approved dairy alkaline detergent (alkaline and acid combinations).

Dairy Cleaning - After every milking, the dairy floor and bails should be scrapped, swept and hosed (or scrubbed) and allowed to dry.

Milk Filtering - All milk should be filtered from the bucket to the milk can with either a nylon mesh or cheese cloth. A clean filter shall be used for each milking. After use the filter shall be, rinsed in cold water, washed with alkaline detergent, washed in boiling water and thoroughly dried, before use the filter shall be rinsed in water containing 140 ppm chlorine.

On Farm Milk Storage – if milk is held on farm a clean milk storage area or room should be available with adequate ventilation so the room is dry and the milk kept as cool as possible. Milk storage area should be fitted with a water bath for milk cooling.

Milk Cooling - Milk should be cooled and maintained at the temperatures listed in the table below according to the delivery time to the processing centre.[9]

Delivery Time to Processing Centre	Standard Temperature (ºC)	Maximum Temperature (ºC)
10 minutes	25º	32º
20 minutes	20º	28º
30 minutes to 1 hour	18º	21º
1 to 3 hours	18º	18º
3 to 6 hours	8º	8º
6 to 12 hours	6º	6º

Milk Transport Containers - Milk should be stored and transported in stainless steel cans with no seams or rivets. They also must have a lid. All containers require an opening large enough to allow hand washing of all areas of the inside of the container and the inside surface should be smooth with no moulded cavities.

Chemical storage - Chemicals should be stored in a separate room/area from the dairy. All containers holding chemicals should be clearly labeled.

4.4.1.2. Cow Health & Hygiene

Udder Preparation - Udders and teats should be cleaned with hands and fresh warm water per cow before milking. Dry with clean paper towels (single use). Washing water should contain 140 ppm of Chlorine.

Teat Spraying - After every milking, the teats on every cow should be sprayed with a suitable teat spray, e.g. water containing 1400 ppm chlorine or 2% iodine with glycerine.


Figure 9: Rapid Mastitis Testing

Colostrum - The following colostrum milk should not be sent for sale: The first 8 complete milkings after calving for adult cows, the first 10 complete milkings after calving for heifers.

Mastitis - Carry out a paddle test (Rapid Mastitis Test) on every cow 4 days after calving and every month thereafter. No milk with a RMT Grade 3 or 4 result should be sent for processing and sold. Keep a record of each cow's test results.

Vaccination of Cattle - All cows should be vaccinated every 6 months for anthrax, Brucella Ovis, Leptospirosis and foot and mouth disease. All cows should be treated for ticks every 6 months.

Diseased Animals - Diseased dairy animals should be identified and kept separate from the milking herd, milk separated and not sold, and records kept of the treatment.

Use of Drugs - Recommended withholding times as stated by the drug manufacturer must be followed (normally this is 48 hours). All treatments must be recorded.

4.4.1.3. Farm Worker

Personal Hygiene - Long hair should be tied back during milking and clothes should be clean. Hands should be washed thoroughly with soap and warm water before milking. If water quality is low hand washing water should be treated with 140 ppm of Chlorine.

Health Certificate - Farm workers must have a current health certificate from the local Food Hygiene Department.

Infectious Diseases - Farm workers milking the cows and handling milking equipment (buckets and filters) should be healthy and free from infectious diseases.

4.4.2. Code of Practice Part II

4.4.2.1. Small Community Based Milk Processing/Collection Centres

The project found that the level of hygiene in some of the small milk processing and collection centers was very low. Some of the staff had little or no understanding of milk hygiene standards or protocol. There was little testing of milk before or after pasteurization and Government UDC 673.141 GB 5408/85 technical requirements were not being applied. Also, most centres lacked the equipment and expertise to be able to undertake even basic milk testing.


Figure 10: Very Small Milk Processing Centre

The first challenge for the project was to get the Milk Processing Centres up to a minimum standard. A very basic "Code of Practice" was developed which covered just the rudimentary requirement; this was seen as the first step in improving the process and try to reduce the immediate health risks. Some of the very small Milk Processing Centres soon realized that they could not meet the standard and should be only Milk Collection Centres, sending milk onto larger processing centres twice daily.

Another real issue identified was the fact that the Milk Processing Centres and Milk Collection Centres were a real danger point for the transfer of animal diseases, via farmers' boots, vehicles and milk containers, disease such as foot & mouth, anthrax and other contagious diseases were present in the province.

4.4.2.2. The Code of Practice for Milk Processing Centres and Milk Collection Centres covered the following basic facets for hygiene standards

There should be distinct areas where hygiene standards can be maintained at independent levels and cross contamination risk is reduced. There should be four such areas in a Milk Processing Centre and three distinct areas in a Milk Collection Centre.

The first barrier needs to be between the Milk Reception (Farmer and Transport Area) and Milk Reception Milk Testing Area:

This forms a disease barrier between the raw milk reception area between where farmers delivered their milk and where raw milk was tested on collection. This milk reception area is only the first line of defense in an overall HACCP process. [10]

Milk reception two areas are:

1. Farmer area – farmers' should enter this area through a chlorine dosed water bath with the milk container and deliver the milk for testing.
2. Milk reception/testing area – farmers should not cross into this area only milk containers are transferred over the line (once milk has passed testing).

Raw milk handling and cooling area:

3. The third area is for raw milk handling processing area only. Between the milk reception and raw milk cooling and processing area there should be a full "Red Line" protocol, i.e. people entering need to change footwear, wear lab coats and wear head protection (hat). Only milk should pass over this red line i.e. poured into a collection vat from the reception area to this area. No farmer's milk containers should enter this area.

Figure 11: Pre & Post Project Milk Transport Standards

The "Red Line" concept is used as the international standard. The "Red Line" forms a conceptual and physical barrier that allows management and staff to maintain different hygiene and standards in different areas of a Milk Processing Centres or Milk Collection Centres. [11] Maintaining the "Red Line" concept is essential for the production of quality milk. This concept needs to be thought through and staff training and involvement is essential. The concept of the "Red Line" methodology needs to be built into a Milk Processing Centre or Milk Collection Centres right from the start when designing the centers.

Pasteurizing Milk Processing Area:

4. In Milk Processing Centres there needs to be a hygiene barrier between raw and pasteurized milk. Contamination of milk after pasteurization is a significant danger. There is high health risk if milk is contaminated post pasteurization, which can lead to a very short shelf life and the high risk of causing food poisoning in the community.

4.4.2.3. Milk Testing

Milk testing and marketing of quality products starts at the farm level with high quality, hygienic, on-farm procedures and milk testing. Milk testing at the Milk Processing Centre is only a validation of good "On-Farm Practice".

Milk testing at small Milk Processing Centres and Milk Collection Centres was a challenge, as the volume of milk passing through the centres was usually low, centres could not sustain high priced, high volume testing equipment.

The following was the basic testing introduced that should be undertaken at the milk reception before milk was accepted:

1. Temperature – the farmer should be encouraged to cool milk before transporting

2. Sensory – an experience technician can grade milk on smell; milk can be tainted by some crops as well as poor hygiene

3. Density – specific gravity provides an indication of the percentage of milk solids and the presence of added water

4. Alcohol Test – this test mainly tests for water or very poor hygiene

5. Somatic Cell Count – the RMT using detergent provides a basic but helpful test for high Somatic Cell Counts (SCC) from mastitis infection in the herd [7]

Figure 12: Pre & Post Project Milk Testing Standards

It is also important that Milk Processing Centres and Milk Collection Centres have the technology, equipment and expertise to undertake:-

a The methyl blue testing of raw and processed milk within the center on a batch by batch basis [12]

b Test milk for fat and protein levels

c Undertake bacterial contamination testing (culturing of swabs) to ensure the plant and equipment are cleaned to a hygiene standard [13]

Random testing by specialized laboratories is also important to check for special strains of bacteria within the plant.

4.5. Results

The number of village based dairy farmers in Guizhou has increased markedly over the last 10-years from approximately 300 to 5,000. The standard of on-farm hygiene has increased with the new "Code of Practice" providing a based for improvement.

There are still a high percentage of cows milked by hand; however, the use of 2-cow milking machines is increasing, the development of larger 5 cow milking shed for 20-50 cows is being considered. However, the capital cost of these is very hard to justify. The introduction of a "Code of Practice" has eliminated the use of non-stainless milk containers. Prior to the project start, there was no mastitis testing on-farm or in the smaller Milk Processing Centres. The introduction of RMT has made a big difference to milk quality.

At one project site 46% of cows tested positive to mastitis at the start of the project and 10% of milk brought to the Milk Processing Centres was rejected due to high SCC. If more adequate milk testing had been available at the start of the project the rejection rate would have been a lot higher.

4.6. Milk Processing and Milk Collection Centres

In the last 5 years the understanding and experience has developed quickly and the new standards developed by the new Milk Processing Centres and Provinces are approaching International Standards and are now well embedded in these centers. Full HACCP protocols have been introduced by the companies themselves, to ensure they meet Government and market expectations.

Figure 13: Pre & Post Project Milk Hygiene Standards

4.7. Conclusion

Small village based dairy production can be viable in Southwest China. For this type of production system to work it needs to be community based, have a sustainable total herd size of over 5,000 cows in a 30km radius of a professionally managed Milk Processing Centre. Strong leadership of farmer led structures is required to develop training, manage supply contracts and source technical knowledge. These community based groups of farmers need access to economically sustainable Milk Processing Centres well managed, as well as good linkages into a wider marketing organization through Joint Ventures and contractual arrangements.

Many of the smaller Milk Processing Centres developed in Southwest China over the last 5-10 years will not be sustainable. Only some of the medium sized, very well managed, will survive. Those with good product range and secure markets for all good fresh milk products as well as a secure farmer supply based which may have to change to compete with the "Big Boys" from the Northern Provinces.

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5. Milking Machine Use And Maintenance

A. Fagerberg[1]

5.1. Background

The milk and other dairy products we consume today are produced by dairy animals – mostly cows. The milk is intended for the calf, but man has through centuries of domestication and breeding created a cow that produces much more milk than the calf will need. Today's modern cows give less than 5% of the milk to the calf and all the rest is used for human consumption.

Originally the small amount of surplus milk was hand milked from the udder after the calf had been fed. Today the cows are machine milked two or three times per 24hours while the calf prefers to suckle several times per day.

The working principle of the milking machine is imitating the calf suckling. The milk is extracted in a rubber liner applied on the teat with a lower pressure (vacuum) than the surrounding atmospheric pressure. In order to avoid damage on the teat the liner is periodically collapsed to create a massage and relief on the teat exposed to vacuum. This is called pulsation and occurs normally once every second.

The working principle was invented almost a century ago and has over time been refined and improved in today's milking machines. This machine is very rare in the sense that it is the only machine that works regularly and routinely with and on an animal for production purposes. It is therefore extremely important that it works in a correct way to not harm the animal or the quality of the milk.

5.2. System design

For milking on the individual farm you need to specify a plant that best meets the requirements on the particular farm. You need to consider how many cows, whether they are tied up or loose and to what extent they are pasture fed. You need to know actual and intended yield levels as well as calving patterns. Labor cost, qualifications and availability will decide level of automation. Technical matters like existing buildings, access to electric power, water quality and availability and access roads will influence plant specifications. Finally also financing and operation costs have to be considered. In many countries there also are laws and regulations that have to be considered.

Technically you have to design the vacuum system to handle milk extraction, milk transport and cleaning. It has to operate with a stable level to assure optimal extraction, It has to consider disturbances like kicked off units or air inlet during putting on the unit. It has to have a capacity to transport the milk without too strong agitation, which will harm the milk quality. Finally it has to have a capacity giving strong turbulence in the cleaning water during the cleaning process.

The pulsation system has to give gentle milking with sufficient capacity to handle high flows of milk without harming teats during low flows. You want the milking to be fast but not harmful.

The capacity for milking has to be matched by the cooling capacity to safeguard the milk quality.

Automation is mostly seen as a way to save on labor cost, but automation can also be a quality assurance by safeguarding a certain work process.

With all these things to consider it is essential to get qualified assistance in specifying the plant. Serious equipment suppliers can do that. By getting the plant specified by one supplier you know whom to contact when there is a problem.

5.3. Installation

To make sure that a correctly specified plant will work properly it has to be installed by a qualified installer.

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Installations where you cut corners by using weak fixtures or unspecified parts often result in unhygienic conditions or operational disturbances. If as an example the milk line is not installed with a proper slope you will get water standing in the pipe between milkings and a high risk for milk quality problems.

Finally a good installation is made in a way that facilitates service and also contributes to the good appearance of the plant

A qualified installer will also train and give instructions to the operators making sure that the plant will be used in the intended way.

5.4. Operation

Milking cows is a highly qualified job that will benefit from a persistent use of correct routines.

Before starting milking make sure all equipment and tools are at hand and in proper condition. Use clean suitable clothing and wash your hands thoroughly before starting milking.

Always handle animals with care and in a calm and considerate way. No yelling or beating if you want them to give you all their milk.

Clean and massage the cow's udder. Use dry cleaning if the udder is clean. If it is so dirty that wet cleaning is required make sure you wipe the teat dry after cleaning. Use disposable cloths for each cow or individual cloths that are cleaned in a washing machine between every milking.

Premilk by hand in a test cup. Take a few squirts from each teat and check for flocculation or blood.

In some countries a special pre dip is used to disinfect the outside of the teat. This will eliminate infections to spread from the outside of the teat to the inside of the same or other teats milked with the same unit.

Put on the milking unit within one minute after preparation. A persistent routine is very important for this action, as the cows will develop a let down reflex that is adjusted to such a routine.

Monitor the milking and adjust the unit if it starts squeaking or if the cow appears uncomfortable.

Take off the unit when the milk flow has ceased or is very low. Check that the udder is empty before you remove the unit. Avoid developing habits were all the cows expect you to aftermilk with machine before taking off. If you use automatic take off units do some random checks that the cows are properly milked.

Teat dip the cows within one minute after take off. This will safeguard disinfection and protection of the teat canal while it still is open.

Register the observations you do on the individual cows during milking. In many production systems milking is the only time of the day when you are close to all the individual lactating cows.

Treated and sick cows shall always be milked separately and after all the healthy cows.

Cows develop habits. If you establish and maintain a persistent milking routine for every milking the cows will feel comfortable and respond positively with an even production.

5.5. Cleaning

The milk from a healthy animal is almost sterile when it leaves the udder. To maintain a high quality of the milk it has to be handled in a clean installation. It is therefore necessary to clean the milking plant thoroughly after each milking.

Sufficient and good quality water is required to achieve a satisfactory cleaning result.

Water heating capacity has to match the requirements from the cleaning procedure.

Detergents have to be selected to work with the actual water quality and dosed in accordance with the instructions given by the equipment supplier.

The hand washing procedures shall follow the supplier's instructions.

If there is an automatic cleaning unit installed it has to be adjusted to the requirements of the plant and water quality and operated according to instructions.

Make sure the cooling tank or cans are equally well cleaned and that you don't forget any part or connection in the whole milk handling chain.

Avoid standing water in and on the cleaned equipment after cleaning and before next milking. Allow drying by having good ventilation or air movements.

5.6. Cooling

To avoid rapid deterioration of the milk after milking it shall be cooled down to 2-4°C within 2 hours. If you don't have access to electric power and/or artificial cooling it is important that you cool the milk by keeping it in the shade and putting it in water from the well or other cool water source. If you can't cool the milk, frequent milk collection at least once per day is required.

If you have a cooling tank it has to have the capacity to cool down the milk within 2 hours. You also have to make sure the milk is not collected before the milk is cooled down.

The agitation of the milk in the tank has to be gentle to avoid milk quality deterioration.

If you can avoid mixing warm milk in cooled that is an advantage from quality point of view.

Clean the tank immediately after the milk has been collected by the truck.

5.7. Maintenance

For a continuous trouble free operation with high quality milk regular maintenance and exchange of wear and tear parts is necessary.

A serious supplier and installer will offer a scheduled plant service to give the required maintenance.

Such a service will include dismantling and a complete cleaning of the plant, exchange of all required wear and tear parts according to established time limits, checking of all essential functions and parameters and a complete test run.

Such preventive scheduled services will markedly reduce operational breakdowns that by experience always will be more costly in the longer perspective.

A preventive service works as an assurance and reduces production losses and gives peace of mind.

5.8. Result

With a correctly specified, installed, operated and maintained milking plant you will be rewarded with a volume of milk according to your cows' present ability and with a quality that meets the highest standards.

The payment for your milk is always related to the volume produced and in most cases also influenced by the quality of the milk measured in some way.

Milk quality can be measured as fat and protein content and then valued as food for human consumption with a certain content of nutrients.

Milk quality can be measured as total bacteria count –TBC-, which measures the hygienic standard of the milk.

Milk quality can also be measured as somatic cell count –SCC-, which measures the animal health or level of mastitis infections in the udder.

Milk quality can also be measured as odor (smell) and taste, which is a measurement of palatability.

Finally contaminations of antibiotic residues, other impurities and water are seen as serious deteriorations of the milk quality.

TBC and SCC are the accepted measurements used to set standards in most OECD countries and international trade regulations. They are also used for various bonus and penalty payment schemes to producers throughout the world.

5.9. China

China has during the last ten years grown its milk production faster than any other nation ever has done. China is today among the ten biggest milk producers in the world.

The rapid expansion of milk production has included massive investments in animals and production facilities. Investments in milking systems have been one big part.

The concept of village milking centers –VMC- was early adopted and has been constantly improved and developed during the growth period.

Today there are thousands of VMCs´in operation for herds with 50 to 2000 cows milked in anything from simple bucket plants to large automated parlours.

To collect the experience from operation of VMCs in China a field study was made during 2005. The study gave a lot of interesting results and some alarming indications about milk quality. The study was therefore followed up by some further field investigations during 2006.

5.10. Field Study

During 2005 we visited twenty production sites in Hebei and Inner Mongolia. During 2006 we added some further tests from sites also in Shaanxi and Anhui. This may not be representative for all of China, but with the present limited access to field study reports in English we find it valuable to publish to allow more parties to add to the development.

Generally all farms had animals with good genetic capacity and modern milking equipment. The main restriction for production volume seems to be feeding, particularly forage quality and quantity.

For milk quality we noticed generally high values for TBC and SCC.

The high TBC values were due to lack of correct detergents, not sufficient hot water and wrong cleaning routines. A complete service of one test plant and correct cleaning routines immediately brought back the TBC value to European standard levels.

The high SCC values indicate frequent mastitis infections in the herds. There is no general quick cure for this. You need to find solutions for each individual production site where you after diagnosis of type of mastitis have to combine treatment and culling with different operation and management changes. The present SCC levels indicate average production losses of 20% in many herds. This is a considerable reduction of potential income to the individual farm as well as the total industry.

5.11. Recommendations

To continue and support the remarkable and fast development of milk production in China we propose the implementation of a Quality Payment System were good performance is encouraged through bonuses above a standard or basic level and substandard performance is observed through a penalty or price reduction.

This has to be implemented in the field and supported by national standards supported and enforced by the authorities.

Such a system will motivate the producers to take the cost of detergents and service to get the additional income from quality bonuses. It will also encourage steps to reduce and eliminate udder diseases, which will lead to more milk, better milk quality and healthier animals.

China has made the major investments in animals and facilities. The addition of a milk quality payment system will make sure it is used in a more proper and optimal way.

5.12. Literature

Maja-Lena Främling, 2005. A study of village milking centre in China. Swedish University of Agricultural Sciences, Department of Animal Nutrition and Management, Uppsala, Sweden.

This paper is written as a background to the oral presentation at the IDF International Dairy Congress 2006 in Shanghai with a power point presentation with several photos and pictures. The complete presentation is available at IDF Head Office or through the editor at www.milk-production.com

6. Dairy Herd Management and Experience: Lessons Learned in the West applied to Emerging Countries

D. Leaver[1]

6.1. Introduction

Management of dairy herds in the West has developed at a rapid rate over the past 25 years [13]. An indicator of this is the substantial increase that has occurred in annual milk yield per cow (Figure 1). Genetic improvement and nutritional management of dairy cows have been main technological drivers of these increases in milk production, and automation related to housing and milking has led to improvements in labour efficiency.

These technical developments in milk production have taken place against a background of large structural changes in the milk production, milk processing and retail sectors of the dairy industry. The structural changes at farm level include a continuing decline in the total number of dairy cows and a steep reduction in the number of dairy farms (Figure 1). The trend towards fewer larger herds is consistent across most EU countries and North America. Adapting to these inevitable structural changes is perhaps the greatest challenge for emerging countries.

A 'Guide to good dairy farming practice' has been produced recently [11] outlining good practice at farm level for animal health, milking hygiene, animal feeding and water, animal welfare and the environment. This paper will consider the developments in the management of dairy herds that have taken place in the West relating to these areas, and discuss some of the lessons both positive and negative for emerging countries.

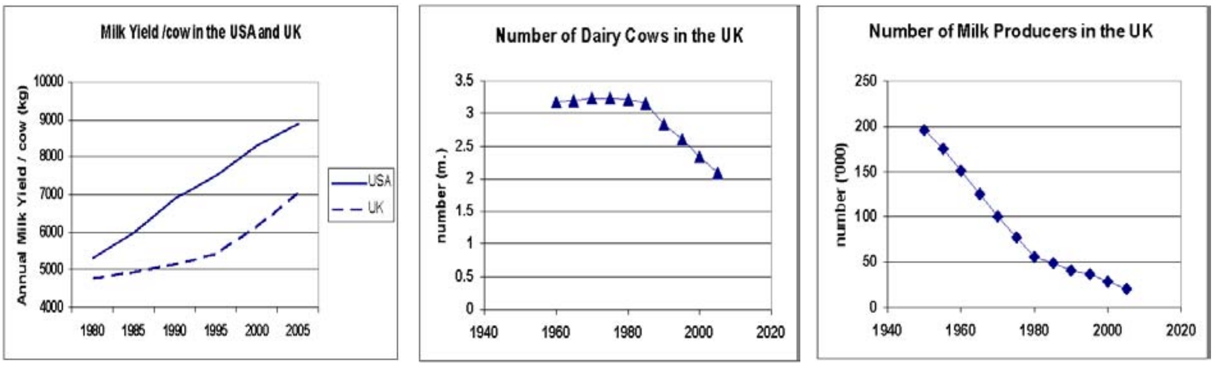

Figure 1. Annual milk yields /cow in the USA [3] and UK, and number of dairy cows and milk producers in the UK from 1980 to the present.

6.2. Genetics

6.2.1. Developments

The growth in computer capacity together with the development of individual animal model methodologies has led to a vastly increased capability for the genetic evaluation of traits that influence the profitability of milk production, using farm-recorded data supplied by milk recording organizations [19]. Also, collaboration between national genetic evaluation schemes such as the International Bull Evaluation Service (Interbull) coordinated in Sweden has meant that genetic proofs for individual sires are now available across a wide range of countries [8]. This has enabled international breeding companies to supply semen from sires that are proven globally, and has led to a trend towards the widespread use of a limited number of 'top sires', and a narrowing of the genetic pool available. The availability of semen from internationally proven

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sires does however provide a means of rapid genetic progress in milk production per cow by emerging countries.

Dairy cows exist in a wide range of physical and nutritional environments, and this raises the question as to whether the sires in widespread use are appropriate for all environments. There are indications that genotype x environment interactions occur in practice, for example between grazing and confinement systems [2]. Therefore different genotypes may be needed for different environments and management systems [10]. It is worth noting that in New Zealand where there is a high reliance on grazed pasture, the cows from high genetic merit bulls are smaller than in the West, and there is a greater use of cross-breeding by dairy farmers.

6.2.2. Animal health and welfare

The selection that has taken place in the West has led to larger cows with lower body condition score, poorer fertility and reduced longevity [9]. Some of these issues are now being addressed by breeding organisations putting greater weighting in selection indices on fertility, mastitis and other longevity traits [22]. These changes should be beneficial to animal health and welfare of dairy herds. At farm level some farmers are addressing 'cow robustness' problems by taking the decision to cross breed and exploit heterosis to improve these low heritability traits (as in New Zealand).

6.2.3. Environmental impacts

The increase in milk yield per cow and the reduced number of cows and replacements required (Figure 1) has had a significant beneficial impact on the environmental footprint of dairy industries in the West through reduced emissions of greenhouse gases (mainly methane and nitrous oxide) and reduced waste nutrients (mainly nitrogen and phosphorus) per kg of output. Methane produced by rumen fermentation is an important contributor to global warming [17], and although the diet can be manipulated to marginally reduce methane production, the major means of reduction is through a reduction in total animal numbers. This is also true for other waste products from dairy systems.

6.2.4. Lessons

The main lessons for emerging countries are that whilst breeding programmes have been highly successful in increasing the efficiency of milk production, the problems of fertility, longevity and adaptation of cows to different management systems still have to be addressed. Each country therefore needs to develop an appropriate strategy within its breeding industry with a clear vision of the types of cows that are required for the particular market and environmental conditions of that country. It is inevitable that animal health, animal welfare and environmental impacts of breeding programmes will have a greater priority in breeding strategies everywhere in future.

6.3. Nutrition

6.3.1. Developments

The genetic improvement of cows for superior milk production has been predominantly a result of selection for larger cows with a propensity to partition an increased proportion of absorbed nutrients to milk rather than to live weight. These cows have a lower body condition score and a consequent higher voluntary food intake. Nevertheless, milk yield per cow has increased at a faster rate than voluntary food intake [5], and one consequence of the lower body condition score has been a decline in fertility levels.

Research into ruminant metabolism is well developed [16], and nutritional knowledge regarding the factors influencing voluntary food intake, nutrient requirements and nutrient supply from different feeds has generated improved nutritional regimes for dairy cattle [24].

6.3.2. Pasture-based and Confinement Systems

In many temperate regions, the cost of grazed grass per kg dry matter is less than for conserved forages and concentrates, and there is increased interest in many countries in pasture-based systems. In regions where pasture for grazing is not available and the cost of concentrates is low relative to that for grazed pasture, there is often an economic justification for high concentrate input systems with associated high daily milk production levels per cow under confinement conditions. However, in regions where grazing of pasture is feasible, it is often more economic to rely on grazed herbage as the major source of nutrients, even though milk production per cow is normally lower on grazing systems than on mixed forage plus concentrate systems, due to the lower daily intakes achieved on grazing [6, 12].

Grazed systems are more likely to be successful where pasture production is high, variability in seasonal supply and quality is low, manufacturing milk accounts for a larger proportion of production and where land is available at relatively low cost [4]. Future developments in pasture-based systems, will depend not only on the profitability of grazed systems relative to confinement systems, but also on future environmental and social policies related to land use which are likely to favour grazing systems [14].

6.3.3. Animal health and welfare

It is claimed that grazed systems have animal welfare benefits compared with confinement systems. Nevertheless there are concerns about the loss of weight and reduced fertility of high genetic merit cows on pasture-based systems, resulting from their relatively low daily dry matter intakes.

6.3.4. Environmental impacts

Decision support in the application of ruminant nutrition is now widely available through computerized diet formulation programs. In addition to formulating diets on a least-cost basis, many of these programs also estimate the nutrient losses in faeces and urine [18]. This will be of increasing importance as there is growing concern about intensive dairy systems in terms of pollution of the environment from waste nutrients, especially from nitrogen and phosphorus. As a consequence, whole farm nutrient balances for nitrogen [20] and phosphorus [21] are increasingly a requirement for assurance purposes.

6.3.5. Lessons

The benefits for emerging countries from previous research in dairy cow nutrition lie in the large bank of knowledge regarding nutrient supply from feeds and their utilisation by cows. Increasing environmental legislation faced by western producers regarding nutrient losses from dairy units, highlights the need for emerging countries to take a systems approach to nutritional management and build environmental planning into feed management systems.

6.4. Housing and Milking

6.4.1. Developments

Over the past 50 years there has been a shift in housing and milking systems from cowsheds to loose housing either in straw yard or in cubicle (free stall) systems with the milking carried out in separate milking parlours. These changes have been driven by the increase in herd sizes, the increase in the number of cows per person, and the switch from hay- to silage-based forage systems that allows full mechanization of feeding.

The innovation of loose housing led to the development of different types of milking parlours, and these have evolved to enable large herds to be milked more quickly. Whereas labour-intensive systems with hand milking can milk about 5-10 cows per man hour and milking machines in cowsheds 25-30 cows per man hour, more automated long static parlours can milk over 80 cows per man hour and large rotary parlours over 200 cows per man hour. Computerisation has also led to greater automation of milking parlours including automatic identification of cows, flagging up of information on individual cows during milking (for example cows treated with antibiotic requiring disposal of their milk), and providing the ability to automatically collect information on individual cows including milk yield and milk conductivity (as an indicator of mastitis), as well as pedometer information (to indicate oestrus or sickness).

The move towards more automated milking systems is determined to a large extent by the high cost of labour in the West. At the extreme, automatic (robotic) milking systems have been developed where a person does not need to be present for milking to take place. However, close supervision is still required and the estimated reduction in staff time is only about 20% [23]. Automatic milking systems are suitable for confinement systems, but present access problems from grazing systems, especially with larger herds.

6.4.2. Animal health and welfare

There has been significant progress over the past 25 years in dairy herd health management, and the epidemiological study of diseases has allowed the multi-factorial nature of health problems to be described and quantified [15]. The strong trend has been towards prevention of disease, and in spite of the increase in herd sizes and cows per person, health problems do not appear to have increased, and for the most part have declined. Also, the sub-clinical nature of some infectious (mastitis, endometritis) and metabolic (ketosis, rumen acidosis) diseases are better recognised and treated.

Animal welfare standards of dairy cows have also improved by the change from cowshed to loose housing systems. However, assessing the best housing system from an animal welfare perspective can be problematical, as the measured indicators of welfare of a system can be both positive and negative compared with an alternative system. For example in loose housing systems, there is a tendency for lameness of dairy cows to be higher in cubicle systems than in straw yard systems, but for mastitis the reverse has been found [7].

6.4.3. Environmental impacts

Losses to the environment from livestock systems are significant [1]. Pasture-based systems lead to losses of ammonia from urine, losses of nitrate through leaching from fertiliser and legume-fixed nitrogen, and losses of nitrous oxide from soils. However, there are substantial additional losses from housed systems as ammonia (from concrete surfaces, from storage systems and during slurry spreading), and as organic matter into water courses from slurry run off and in effluent seapage from silos.

6.4.4. Lessons

Developments in buildings, milking systems and automation systems are taking place continuously. Ensuring cows are free from discomfort, pain, injury and disease, and limiting environmental impact of dairy systems are high priorities in the development of acceptable housing and milking management systems.

6.5. Summary and Conclusions

For emerging countries to be competitive, the main driver for management systems will have to be similar to that of the West, namely the improvement of productivity and profitability of milk production.

Nevertheless, the development of sustainable management systems is now a high priority everywhere as social aspects (animal welfare, quality of product, food safety) and environmental aspects (air and water pollution, climate change, landscape) of milk production are of increasing importance to both consumers and exporters.

Intensification and industrialisation of management systems do however increase the risk of catastrophic breakdown of systems. The emergence of bovine spongiforum encephalopathy

(BSE), thought to be derived from cows consuming the offal of other ruminant animal as meat and bone meal, is a sobering example of the need to intensify and reduce costs with great care.

In contrast, low input management systems such as pasture-based grazing result in a greater output of waste nutrients and greenhouse gases per kg output than more intensive confinement systems. This illustrates the paradox when interpreting sustainability indicators, and highlights the need for emerging countries to evaluate these complex issues objectively in relation to their own needs.

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GOOD DAIRY FARMING PRACTICES RELATED TO PRIMARY PRODUCTION OF MILK AND FARM MANAGEMENT

ABSTRACT

Proceedings of the conference on Good Dairy Farming Practices related to Primary Production of Milk and Farm Management , at the IDF World Dairy Congress in Shanghai, China, October 2006. Papers cover the importance of Good Farming Practice, milk production methods and animal feed in China, the Codex Alimentarius Code of Practice on Good Animal Feeding, dairy herd management, nutritional approaches to dairy animals in India, hygiene on the farm, and the use and maintenance of milking machines.

Keywords: animal health, Codex, dairy farming, dairy development, farm, farm management, feed, feeding, GDFP, genetics, GFP, good practice, herd, hygiene, machine milking, milking, production

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“.......Usually double quotes and not single quotes
? !.......Half-space before and after question marks, and exclamation marks
± ....Half-space before and after
micr<u>oo</u>rganisms.......Without a hyphen
Infra-red ....With a hyphen
et al........Not underlined nor italic
e.g., i.e.,... ....Spelled out in English - for example, that is
lit<u>re</u>.......Not liter unless the author is American
ml, mg,... ....Space between number and ml, mg,...
skimmilk ....One word if adjective, two words if substantive
sulfuric, sulfite, sulfate.......Not sulphuric, sulphite, sulphate (as agreed by IUPAC)
AOAC <u>International</u> ....Not AOAC<u>I</u>
progra<u>mme</u>.......Not program unless a) author is American or b) computer program
milk and milk product ....rather than “milk and dairy product” - Normally some latitude can be allowed in non scientific texts
-ize, -ization ....Not -ise, -isation with a few exceptions
Decimal comma.......in Standards (only) in both languages (as agreed by ISO)
No space between figure and % - i.e. 6%, etc.
Milkfat.......One word
USA, UK, GB.......No stops
Figure.......To be written out in full
1000-9000 ....No comma
10 000, etc. ....No comma, but space
hours.......ø h
second.......ø s
litre.......ø l
<u>t</u>he Netherlands
Where two or more authors are involved with a text, both names are given on one line, followed by their affiliations, as footnotes
for example A.A. Uthar[1] & B. Prof[2]
[1] University of ....
[2] Danish Dairy Board .....
IDF does not spell out international organizations

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