MODULE ON:

DAIRY PRODUCTS QUALITY AND SAFETY

Time: 27 Contact Hours

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MODULE 1

DAIRY PRODUCTS QUALITY AND SAFETY

TOPIC 1

Introduction and foundational concepts of milk quality and safety

TIME:

1 hour 36 minutes

AUTHOR:

MAK

OUTCOMES:

By completion of this topic you will:

- Plan and investigate milk quality and safety
- Apply and incorporate the principles of milk quality and safety
- Apply the principles of quality assurance system to control and assure the quality and safe of milk products
- Understand government regulations related to quality assurance
- Apply quality management tools to collect, organize, analyze and evaluate data
- Describe and compare the principles of quality management systems (HACCP)

INTRODUCTION:

Definition of Milk

Milk may be defined as the whole, fresh, clean lacteal secretion obtained by the complete milking of one or more healthy milking animals, excluding that obtained within 15 days before or 5 days after calving (such periods where milk is rendered practically colostrum free, and containing the minimum prescribed percentage of milk fat and milk-solids that are non- fat).

Milks and milk products have been important human food items for centuries. Milks are mostly obtained from cows, goats, and sheep in Africa and Uganda. However, in some cultures, milks have been obtained from buffaloes, camels, donkeys, and horses. Milk is mainly an essential food during infancy.

Milk is highly nutritious and is one of the few foods that can sustain a young one (both animals and humans) without supplementation. Being nutritious in nature, it also serves as an excellent medium for growth of micro-organisms.

The concepts of milk quality

Milk quality refers to a combination of characteristics that enhance the acceptability of the milk product. Quality relates to chemical, physical, technological, bacteriological and aesthetic characteristics of milk and milk products.

Table 1 Compositional quality of milk

Constituent	Average %	Range %
Fat	3.7	2.5-6.0
Protein	3.3	2.9-5.0
Lactose	4.8	3.6-5.5
Mineral	0.7	0.6-0.8
Water	87.5	5-89.5

Table 2 Physico-chemical properties of milk (Cow Milk)

Property	Range
Acidity	0.13-0.14%
pH	6.4-6.6%
Specific gravidity	1.028-1.03%
Freezing point	0.549^0C
Colour	Yellow creamy white
Flavour	Sweat taste of lactose and salty taste

Factors affecting milk composition

All milks contain the same constituents but these vary in amounts thus making milks differ in their compositions with milk fats showing the greatest variation followed by proteins and lactose. The various factors that affect the composition of milk include:
Species: Each species of animal yields milk of different compositions.
Breeds: High yielding animals produce milk with lower fat percentage e.g. Friesian vs. Jersey cows.
Individual variation: There is variation between individual animals.
Season: Variations are evident during the course of the year (especially fats being highest during dry seasons).
Age: The fat percentage increases up to 3rd lactation and afterwards decreases.
Milking interval: With longer intervals between milking, the yield is greater with a corresponding decrease in fat content and vice versa.
Completeness of milking: First milk contains less fat and last milk contains high fat. If the milking is not complete, the milk tests for less fat.
Irregularity in milking: Frequent changes in the milking timings, and frequent changes in milking intervals results less fat

What other factors do you think can affect milk composition?

Other factors affecting milk composition

Yield: With increase in yield per milking the percentage of lactose increases, while fat decreases.
Lactose effect: The first secretion after parturition (colostrum) has high globules and chlorides and low lactose content. The yield increases and attains maximum within 2-4 weeks and then slowly decreases.
Exercise: More exercise increases fat in milk as body fat is metabolized
Excitement: Sexual excitement or fear causes decrease in fat content.
Hormones: Prolactin and thyroid hormones are essential for milk production and increase fat percentage. Oestrogen decreases it.
Udder diseases: Mastitis and other diseases cause low lactose and casein percentage as well as low chloride content.
Physiological condition: Time of parturition has an effect on fat content.
Pasture feeding: Pasture feeding increases fat content (unsaturated fatty acids) in milk.
Feeding: Supplementation with feeding oils increases fat content.

Reflection: From your own experience, how can a farmer keep his or her milk safe for use (consumption, processing, and packaging in Uganda`s environment or your country? As you walk through this module, these are some of the issues one should think about and or generate pragmatic mitigation strategies where need be with regard to the existing challanges.

The concept of milk safety

Milk safety refers to a condition in which the risk of milk to harm and damage is limited to an acceptable level.

The nutritious nature of milk serves as an excellent medium for growth of micro-organisms. Some of these micro-organisms cause illness to humans and others cause spoilage in milk rendering it unfit (unsafe) for consumption.
It is impossible to produce sterile milk. Sources of contamination include commensal or pathogenic flora of the animal and/or animal handler and/or machinery.
Pasteurization, the most common method of decontaminating milk, kills most potential pathogens but does not sterilize the milk. Milk is usually pasteurized before it is placed in containers for sale, so post pasteurization contamination can also occur.

Milk products available on the Ugandan market

1. Pasteurized milk
2. UHT Milk
3. Cheese
4. Cream and ice cream
5. Yoghurt
6. Cultured milk
7. Butter and ghee

Milk quality and safety regulation in Uganda

In Uganda, there is lack of an efficient regulatory mechanism as observed by K2-Consult (2002). This was suggested after noting that regulations in existing laws such as the Dairy Industry Act of 1998, which provides for processing and marketing standards are commonly ignored. This problem is attributed to light penalties and constraints of law enforcement. The fact that the standards may not be practical from the point of view of market agents and consumers is not considered.

The Uganda National Bureau of Standards has completed formulation of a Code of Practice for Raw Milk Handling and Marketing. However, it is unclear to what extent such top-down regulations will be observed by the mostly small agents in the dairy industry.

TOPIC 2

The dairy industry, governance, policy and legislation in Uganda

Dairy production systems in Uganda

Dairy production systems in Uganda are diversely designed and operated. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) jointly with the International Livestock Research Institute (ILRI) (MAAIF/ILRI 1996) indicated that cattle production systems in Uganda form a continuum with semi-nomadic pastoralism at one end and zero grazing on the other. Pastoralists are more oriented towards subsistence and accumulation of capital in cattle to help address risk, while zero-grazing farmers have a market orientation.

Depending on the level of investment in both capital and dairy cattle management, MAAIF/ILRI (1996) categorized dairy production into three systems: Intensive, Semi-intensive and Extensive dairying systems.
For the purpose of evaluating efficiencies in milk production systems K2-Consult (2002) categorized dairying into four groups:

1. **Communal grazing**: Cows graze freely on communal land owned by the clan.
2. **Free range grazing**: Cows move about all over the farm with no one herding.
3. **Fenced grazing**: Cows graze around paddocks, and also eat concentrates.
4. **Zero grazing**: Cows do not graze; they are fed with concentrates and grass.

Depending on the size of the grazing systems the categories were further divided according to sizes, leading to small, medium and large-scale farmers in each production system.

On the other hand, Fonteh et al (1998) conducted a more detailed characterization within smallholder dairy systems in Uganda and ended up with three categories, namely, urban, peri-urban and rural.
Makerere Univesrity School of Veterinary Medicine advocates for K2-Consult (2002)

Economics of milk production in Uganda

In Uganda, the dairy sector contributed 40-50% of the livestock GDP in 2001 (DDA 2001/2002), which in turn contributed 17-19% of the agricultural GDP. In the 2007/08 financial year review, the livestock sub sector contributed 18% of agriculture gross domestic product and 9% of the national gross domestic product. Of the GDP attributed to the livestock sub sector, the dairy sector is estimated to contribute up to 45%. According the Dairy Development Authority, Uganda's annual milk yield has averaged 1.4 billion litres over the last 3 years: 30% of this is retained at the farms and only about 980 million litres is commercially traded; 83% of it is consumed unprocessed. Dairy plays a crucial role in the nutrition of most households. The per capita consumption of milk has increased over the last five years from a low of 40 litres per year in 2001 to a level of 50 litres as of 2007.However; this is still below the World Health Organization recommended level of 200 litres/person/year. In urban areas, the per capita consumption is higher and estimated at 48 litres/year, while in rural areas it is estimated at 22 litres/year.

The K-2 survey indicates that consumption in the Central Region (including Kampala) is highest with 91 litres per year; Western region is the second highest in the country averaging 51.7 litres per person per year. Consumption is lowest in the North at 15.6 litres per year due to limited supply. Overall milk consumption is growing at an average rate estimated at 8% per annum. Table 3 shows the per capita consumption of milk since 1997.

Table 3 showing per capita consumption of fluid milk

Year	Per capita consumption (litres/person/year)
1997	28.5
1998	29.5
1999	30.0
2000	38.1
2001	40.0
2007	50.0

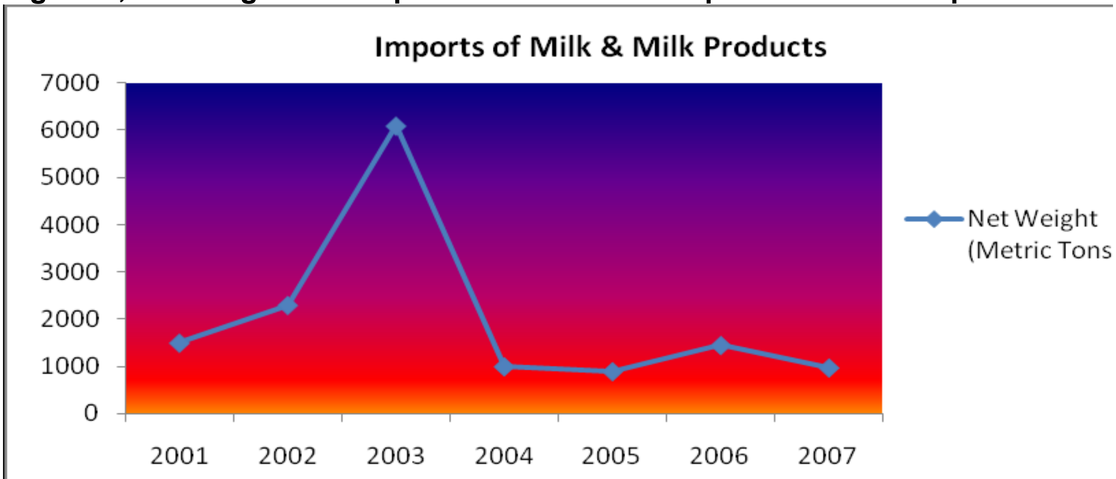
Source: Ministry of Agriculture animal and Fisheries; Dairy Development Authority

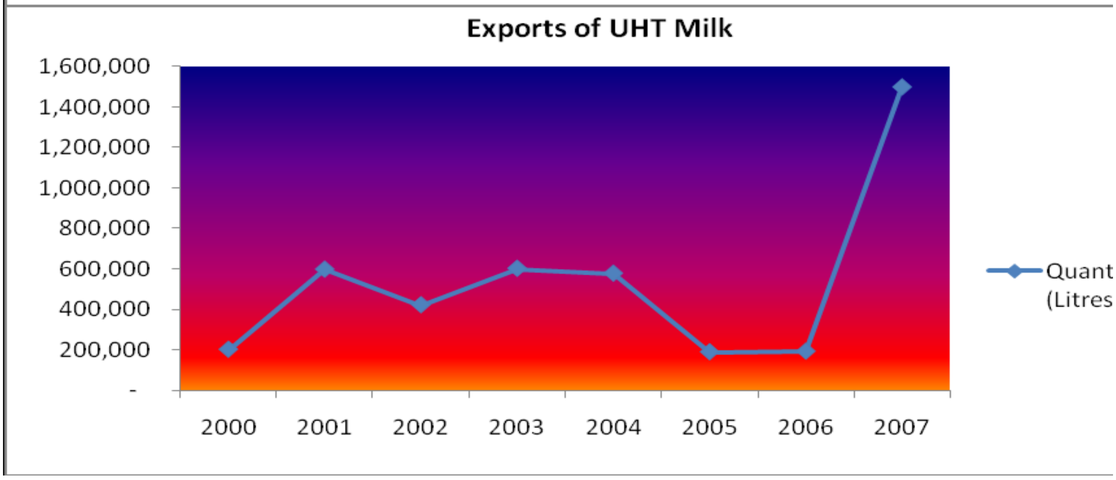
The demand for milk in Uganda comes from households, schools, hospitals, catering institutions, food and dairy processing plants. According to the Dairy Development Authority annual report 2007, the demand for processed milk is estimated at 400 million litres per year. The demand for milk from processing plants and other consumers is expected to increase.

As noted previously, Uganda produces a variety of milk products including; pasteurized milk, UHT milk, cheese, yoghurt, cultured milk, butter, ghee, creams and ice cream. A substantial amount of milk and milk products is also imported indicating that the domestic production is not sufficient to meet market demands. Uganda also exports dairy products mainly to the regional market. The annual growth rate of milk production between 2001 and 2006 has been 9 percent leading to the total national milk output growing from 900 million litres in 2001 to 1,400 million in 2006.

The total quantity of milk and milk products imported has been declining progressively since 2003.

Figure 1; show Uganda's imports of milk and milk products. UHT Exports





Source: Dairy Development Authority 2007 Report

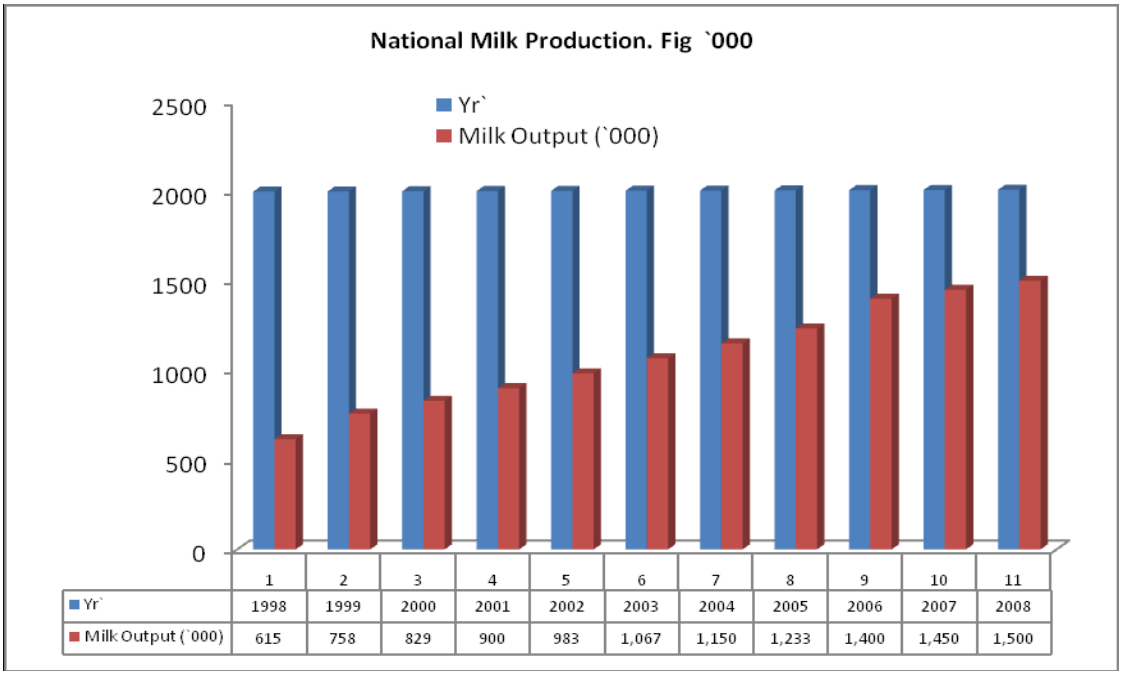
Dairy export trade

UHT milk is the main dairy product exported to regional markets, including Rwanda, Kenya, Tanzania, DR Congo, Southern Sudan, Egypt and Mauritius. Informal dairy trade goes on across all the borders of Uganda.

The volume of milk exported declined progressively from 2003 to 2006 but increased to 1.5 metric tons in 2007. The increase in 2007 was mainly driven by the opening up of the Southern Sudan and DR Congo Market. This was not only for milk but also for all other exports. Between 2000 and 2006, Uganda exported an average of 380 metric tons of milk per year. Figure 2, below illustrates the trend in dairy exports between 2000 and 2007.

The milk supply chain in Uganda entails the flow of milk from the farm level, through the trader/agents/transporters, milk collection centres and processors and finally to the consumer.

Milk production has been on the increase since 1998, where national production was at 615 million litres to 1.45 million in 2007. It was estimated to close at 1.5 million litres by end of 2008. Below is a graph showing annual national milk production in Uganda.



	1	2	3	4	5	6	7	8	9	10	11
Yr`	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Milk Output (`000)	615	758	829	900	983	1,067	1,150	1,233	1,400	1,450	1,500

Source: Dairy Development Authority Report 2007/08

Dairy development policies in Uganda

With reform of the dairy industry in Uganda, the Dairy Master Plan (1993) has provided the key guidelines for transformation of the sector particularly liberalization of the dairy industry, establishment of a regulatory body as well as restructuring and privatization of the state owned dairy-processing company, which is now at an advanced stage. The Dairy Industry Act*, 1998* is the main law under which the new institutional and policy reforms in the sector are being implemented. This has been supported by the general livestock sector policies such as the *Policy on marketing of livestock and livestock products, Animal health policies*, the *Animal breeding policy*, as well as the *Public Health Act* and the broad national policies and strategies such as Liberalization, Privatization, Decentralization policy (Local Government Act); the Poverty Eradication Action Plan (PEAP), Plan for Modernization of Agriculture (PMA) and the National Agricultural Advisory Services (NAADS).

At the milk-shed level, the liberalization policy has resulted in an upsurge in the number of traders and processors vying to purchase the milk and an increase in competition, better milk prices and a more reliable market. Under the decentralization policy, local governments levy taxes on dairy and dairy related businesses. Milk traders who set up milk vending outlets in urban centres are required to pay for annual trading licenses up to as much as US$ 100. Hawkers and vendors who sell milk in urban areas are obliged to pay a small fee ranging between 200/= (US$ 0.1) and 500/= (US$ 0.25) per day to the local authorities.

In some areas dairy farmers who deliver milk to bulking facilities within town councils are required to pay for an annual licence ranging between U Shs 10,000/= and 20,000/= (US$ 5 and 10) per year depending on the amount of milk delivered per day. The Dairy Development Authority is responsible for promoting and monitoring quality in the dairy industry through enforcement of standards and regulations.

The Authority develops new and updates existing standards in liaison with the Uganda National Bureau of Standards (UNBS). The government released new regulations, **"***The Dairy (Marketing and Processing of Milk and Milk Products) Regulations, 2003***",** which provide the framework for enforcement of quality standards and good hygiene and handling practices. DDA in liaison with UNBS has developed the *code of hygienic practice for Milk and Milk Products***.** The document provides guidelines for hygienic production and handling of milk and milk products at different stages of the dairy chain There are several other legal documents (Policies, Acts of Parliament, Ordinances of Local Authorities, etc) being implemented by different government institutions/departments but which also address dairy related issues. The *Public Health (sale of Milk and Milk Products) Rules, the Kampala City (Sale of Milk and Milk Products) Ordinance and the UNBS Standards* for milk and milk products are all concerned with the standards for marketable milk and milk products, as well as the requirements for handlers and handling facilities. The need for harmonization of the content of different statutory instruments/ legal documents in respect of the quality and handling of milk and milk products cannot be overemphasized.

Dairy development policies in Uganda

In order to enhance quality in the dairy chain, DDA, on behalf of government, outlawed the use of plastic receptacles/equipment for handling and transporting milk.

The Authority also registers and inspects all facilities for handling and processing milk and milk products. Facilities that meet the minimum requirements are issued with a registration certificate after paying an annual registration fee. The Authority also promotes the training of dairy stakeholders on quality, and good hygiene and handling practices for milk and milk products.

There is a formidable challenge to improve the quality and handling of milk at farm level. This study revealed that milk-handling practices are generally poor.

Despite the fact that Uganda has an elaborate regulatory framework, the private sector in the industry is not properly organized to respond to the sector's challenges and take advantage of the available market opportunities.

Cooperative systems of Africa

Successive governments since the 1960s partly saw the cooperative movement as an instrument of control and an informal mechanism through which rural surplus could be extracted for the benefit of the urban dwellers while at the same time improving the incomes and quality of life of rural communities. However, the cooperative system was abused and cooperatives lost the purpose for which they were created. Cronyism became rampant and often the hard-earned savings of society members were misappropriated.

With the adoption of Structural Adjustment Programmes (SAPs) by the government of Uganda in the 1990s, the financial support to cooperatives through the marketing boards dried up. Since cooperatives had never learnt how to be financially self-reliant, they started collapsing one by one especially with private sector competition becoming more severe. The challenges remain but opportunities for cooperatives to succeed in today's competitive environment also exist.

Recently, new co -operative societies have developed and many of them are involved in milk collection and marketing. Some have gone into milk processing. The Uganda Dairy Industry Stakeholders Association (UDISA), an organization of all stakeholders in the dairy Industry was recently formed. UDISA, together with Uganda National Bureau of Standards. Has completed the formulation of the Code of Practice for Raw Milk Handing and Marketing.

In the areas where cooperatives have been revived, farmers are beginning to reap profits in terms of more stable prices and regular payments. In an interview with Mr. Grace, the chairman of Biharwe Farmers Association, it was established that farmers in Mbarara have negotiated a fixed price for milk throughout the year and guarantee to buy all milk that is collected. This has made farmers' incomes more predictable than they used to be.

In 2005, Uganda Crane Creameries Cooperative Union was born out of the Western Uganda Dairies Association. It has a membership of 7 district cooperative unions, 76 primary society/milk collection centres (MCC) and a total of 10,500 dairy farmers. The East African Dairy Development Project will hopefully help small-scale producers escape from poverty.

The public and government agencies

The dairy sector is one of the sectors that had been under government control for some time with the Uganda Dairy Corporation dominating. There have been other agencies that are have played a big role to promote the dairy industry in the country.

East Africa Dairy Development (EADD) Project
This operates in three countries, Uganda, Kenya and Rwanda, under the Bill and Melinda Gates Foundation grant (US$ 42.8 million) over a period of four years with an objective of poverty eradication among small-scale dairy farmers. The project which was announced at the end of January 2008 is being implemented by Heifer International Uganda in partnership with TechnoServe and the International Livestock Research Institute (ILRI). In Uganda, the EADD project supports a sustainable dairy value chain that will result in increased income, market share and market participation of smallholder farming households in 15 districts.

Heifer International Uganda (HPU)
HPU has been in Uganda since 1982 involved in assisting resource-poor households to work towards ending hunger, poverty and to care for the environment through livestock distribution and health care, training and education, enterprise development, livestock services and environmental management (agro-ecology).

TechnoServe Uganda
TechnoServe is an International non-profit economic development organization founded in the USA. Work in the dairy sector by TechnoServe is commencing with the grant from the Bill and Melinda Gates Foundation to help entrepreneurial men and women in poor rural areas of the developing world to build businesses that create income, opportunity and economic growth for their families, their communities and their countries.

Land O’Lakes Inc
Land O’Lakes Inc is a not-for-profit organization founded in the USA. Since 1994, Land O’Lakes has been providing technical support to Uganda’s dairy sector in the area of market development; processing, marketing, and distribution of value-added products, milk bulking and handling, production, industry organization and policy reforms. The project operated from 1st October 2001 to 30th September 2004.

Send A Cow Uganda
Send a Cow is a charity organization that has been providing dairy animals to poor households (especially those headed by women) since 1988. The organization was founded in 1988 in response to a plea from a Ugandan bishop to Christian Communities in the UK. Send A cow is currently implementing three programmes in Uganda: one in each of the Eastern, Central and Northern regions. The core of each of the three programmes is similar. All beneficiaries get training in group work and organic farming. They are all given livestock, mainly dairy cows or goats.

DANIDA Support to Dairy Development Authority

The Danish International Development Agency (DANIDA) is one of the development partners that have contributed substantially to development of Uganda's dairy industry since the end of war in 1986. Details of support provided by DANIDA and other Development Partners are outlined in the paper on Rehabilitation of the Dairy Industry in Uganda prepared by Okwenye A.A and published by FAO Document Repository on the internet: http://www.fao.docrep/T3080T/t3080T04.htm.

French ACSS Project

The ACSS project funded by the French Development Agency through the Priority Solidarity Fund (PSF) was implemented over a period of 67 months until 31st December 2007. The objective of the project was to support implementation of the Plan for Modernization of Agriculture, by contributing to the process of strengthening the participation of farmers' organizations at local and national level, in economic activities and in agricultural policy design, by drawing experience from activities implemented in a particular sector (milk) and region (South Western). From July 2005 to December 2007, implementation of the project was entrusted to the Dairy Development Authority.

Uganda National Agro-Input Dealers Association (UNADA)

The UNADA is the national apex organization for private dealers of agro inputs and offers extension service. It was registered in 2003 under the NGO statute. It operates in 10 UNADA regions in the country, using 5 programme officers. It aims to actively contribute to modernization of Uganda's agriculture and participate in projects aimed at bringing development to the agricultural sector.

Other NGOs and Community Based Organizations

There are several international and local charity organizations that provide livestock to resource-poor households particularly in the war ravaged areas of Northern, Eastern and Western Uganda. In most cases, dairy animals are provided under the food security component of the charity with a view to improving the nutrition and income of the households. In addition to the animal gifts, the charities provide training and other livestock services to the beneficiary households. Examples of such organizations are Church of Uganda, CARITUS, Christian Children's Fund, Africa 2000 Network, World Vision and the Red Cross among others. In general, the scale of investment in the dairy sector is very limited.

There are groups and associations that have organized themselves to influence the supply and demand of the dairy industry sector and these are: the Uganda National Dairy farmers Association/groups, transporters, vendors and processors. These groups influence standards as well as market conditions in terms of supply and demand for the products. However. the milk and dairy products market in Uganda has been liberalized since the early 1990s whereby the price of both raw milk and its products are determined by market forces to a larger extent. This has led to free participation of the private sector and also increased informal marketing standards and regulations for dairy products. Unlike other regions, the South Western part of Uganda has revived the cooperative movement; this has led to the formation of the Uganda Crane Creameries Cooperative Union with a membership of seven (7) district unions, 76 primary societies/MCC, and 10,500 dairy farmers. Its mandate is to represent the views of the farmers as a single voice.

Currently the milk market comprises two main categories namely: the formal and informal sector. There are categories of milk buyers and vendors. The first categories are the bicycle vendors who buy milk from farmers and sell it from house to house. Secondly, there are the licensed traders who own coolers and sell milk on a wholesale or retail basis. Then there are established and licensed processors who process pack and sale milk and milk products to consumers where the demand for milk is high. The milk marketing chains are therefore two-fold; the processed milk chain and unprocessed milk chain. The boundaries between the two chains are at times porous and continuously shifting. Since the vendors and some licensed traders have no regular suppliers, they receive milk of variable quality. However, the informal/unprocessed milk chain is flexible enough to undercut the prices offered by the processors more regular and upfront payments system. Given their lower overhead costs, vendors and licensed traders have managed to out-compete the formal/processed milk chain and this has constrained the growth of the large-scale milk industry. Table 4 provides a comparison of the two milk supply chains in operation.

Table 4 Key characteristics of milk chain in Uganda

Processed Milk Chain	**Unprocessed Milk Chain**
• Test the raw milk at the farm level to ensure quality	• Do not usually test the milk and quality is not an issue
• Largely use modern methods to preserve the milk and quality is an important issue.	• Use traditional methods like boiling to preserve milk
• Obtain fresh milk from key established suppliers	• Obtain milk from any source
• Maintain contact and collaborate with suppliers	• Often have no attachment to suppliers
• Deal in processed milk with a longer shelf life	• Deal in raw milk with a very short shelf life.

New approaches in technology: cloning, factory farming, genetic engineering and the rise of organic dairy

The National Agricultural Research Organization (NARO) is responsible for research and development in the livestock sector. Different NARO divisions undertake research and development in animal health, breeding and nutrition of livestock. The Animal Breeding Centre (ABC) also produces semen and offers artificial insemination (AI) services to private farmers. Veterinary services in the country are now privatized and are easily available. The liberalization of the dairy sector has led to:

Improvement of the dairy herds

The breeds/types of cattle kept by farmers in Uganda include indigenous cattle (predominantly Ankole and Zebu), exotic cattle (Frisian, Guernsey and Jersey), and cross-breed. The indigenous cattle account for 82.7% of the herd population in Uganda. The number of cross-breed/exotic cattle is 1.3m (17.3%). The government's deliberate policy to support and encourage farmers to keep exotic and cross-breeds inspired the development of the milk industry in all parts of Uganda.

There has been an improvement in the dairy herds in most of the dairy districts across the country. In the districts of Mbarara, Bushenyi, Ntungamo, Ibanda and Kamwenge, dairy farmers have taken measures to improve farm productivity with available land resources. Following liberalization of the sector, there has been increased demand and better prices brought about by increased competition. Farmers are encouraged by increased output to respond to the positive market signals. Four out of the twelve milk-processing factories are located in Mbarara and farmers know that the best way to increase output and make more money is to introduce exotic animals especially of the Friesian type whose output of milk is more than three times the output of local breeds. In the counties of Ngoma and Kajara, in Ntungamo, over the last decade dairy farmers have become more settled and modernized with fewer of them being pastoral with improvements in their herds, pastures and pad docking. This is reflected in their increased yields of milk.

The exotic cattle however require higher maintenance costs and farmers are expected to cover these costs from higher prices and incomes.

Infectious contaminants of milk and

TOPIC 3

Basic milk microbiology

Milk is virtually sterile when synthesized in a healthy cow. Cows, like humans, are natural reservoirs of bacteria, many of which are not harmful to humans, but some may be harmful to humans even though the cows are not affected and appear healthy.

Milk may become contaminated with bacteria during or after milking. Contamination may occur in cases when the disease-causing organisms (pathogens) are shed through cow faeces contaminating the outside of the udder and teats, the farm environment (e.g. bedding) and the milking equipment. Although optimal growth conditions for bacteria are different for different organisms, milk contains important nutritional components for mammal growth, and, therefore, it is also an ideal medium for the growth of many different bacteria. Temperature plays an important role in bacterial growth. Many bacteria prefer to grow at body temperature (86-98°F, 30-37°C), but will grow at lower temperatures (such as refrigerator temperature) at slower rates.

The extent of the contamination that takes place, depends upon the hygienic measures taken before, during and after the milking process and storage. The bacteria present in dairy products may cause disease or spoilage. Some bacteria may be specifically added to milk for fermentation to produce products like yogurt and cheese. Human illness from milk-borne pathogens is usually associated with consumption of raw milk or products made from raw milk such as fresh cheeses.

Nearly all the changes that take place in the flavor and appearance of the milk after it is drawn from the cow, are the result of the activities of micro-organisms.Therefore, it is essential to control these micro-organisms.

The significance of micro-organisms in milk is as follows:

- Microbial content serves as an indicator of production conditions and the sanitary quality of milk
- Prevention of spoilage
- Prevention of milk-borne illnesses
- Production of dairy products with desired characteristics imparted via micro-organism introduction.

The types of micro-organisms in milk vary considerably and may include bacteria, yeasts, moulds and bacteriophages. Viruses and protozoa are seldom observed in milk, except as occasional contaminants. Bacteria are the most common and most numerous micro-organisms found in milk and milk products. They can be used as starter cultures for the production of cultured dairy products.

Factors affecting growth of micro-organisms in milk

These include;

1. Food supply (water, energy, Carbon, Nitrogen, Vitamins and minerals)
2. Moisture
3. Oxygen supply (obligate aerobes, facultative, micoaerophillic, obligate anaerobes)
4. Acidity and pH (Acidophillic)
5. Preservatives
6. Light (phototrophic)
7. Concentration (osmophillic)
8. Temperature (psychotrophs-20-30; Mesophiles-30-40, Thermophiles-55-65^{0}C)
9. Antimicrobial constituents

Means of destruction of micro-organisms

1. Heat-pasteurization, sterilization
2. Ionizing radiations e.g. UV, gamma rays
3. Electricity-by heat generated
4. Pressure-600 x> atmospheric pressure
5. Chemicals acids, alkalis, halogens H_2O_2

Sources of contamination

Sources of contamination include commensal or pathogenic flora of the udder or teat canal, the animal's skin, faecal soiling of the udder, contaminated milking equipment, and water used to clean the milking equipment, and milk storage containers. In addition, commensal or pathogenic organisms from milkers, insects, rodents, birds, and other animals may enter milk. Therefore, key sources of contaminants are: cow (teat, skin); human (hands of the milker, drugs/chemicals used during treatment); air/environment; equipment (harvest and storage)

Milk-borne infections

A variety of micro organisms may gain access to milk and milk products from different sources and cause different types of food-borne illnesses. Milk and milk products may carry organisms as such or their toxic metabolites (poisons) called toxins.

Organisms from human carriers, the environment, milk-producing animals, or other animals have been agents of milk borne disease such as the following:

Milk borne infections

- Bovine tuberculosis
- Brucellosis
- Anthrax
- Salmonellosis
- Listeriosis
- Leptospira infection
- Q fever
- Foot and mouth disease
- Toxoplasmosis
- Hypersensitivity reactions

Contamination of milk by human beings

- Septic sore throat and diphtheria
- Typhoid fever
- Paratyphoid fever
- Infectious hepatitis
- Polio infection
- Enteritis
- Amoebiasis
- Giardiasis

Contamination of milk from environment

- Botulism
- Coli infection
- Rat bite fever
- Balentidiasis.

Organisms from human carriers have largely been eliminated by general improvements in water supplies, public health and hygiene, and pasteurization. Organisms from the animals that produce the milk or from the environment have been reduced by improvements in animal husbandry, environmental cleanliness in dairies and processing plants, and pasteurization.

Epidemiology and investigations of milk borne Zoonoses

In the past 20 years, food borne illnesses from dairy product consumption have been predominantly associated with *Salmonella enterica*, *Listeria monocytogenes*, *Campylobacter jejuni*, and *Escherichia coli* O157:H7. These organisms have been isolated from bulk tank samples at rates ranging from 0.87% of samples taken for *E. coli* O157:H7 analysis in Ontario, Canada to 10% for *E. coli* O157:H7 in Wisconsin (Jayarao et al., 2001 and 2006; Van Kessel et al., 2004). Because there is a risk of pathogen contamination in milk produced from healthy cows under sanitary milk conditions, pasteurization of milk prior to consumption will destroy pathogens and provide protection for illness associated with consumption of dangerous microbes. Occasionally, human illness has been linked to pasteurized milk products but these cases usually have been a result of contamination of the product after pasteurization or improper pasteurization.

A study in Tanzania (Mdegela et al., 2004) determined prevalence and determinants of milk borne zoonoses. In the study the seroconversion for brucellosis was evaluated using enzyme-linked immunosorbent assay (ELISA). Animals were also tuberculin-tested using a single comparative intradermal method and milk samples were cultured for isolation of *Mycobacterium* species. The prevalence of bovine tuberculosis was 0.4% and 1.7% in Kibaha and Morogoro, respectively. Similarly, the prevalence of brucellosis was 1% in Kibaha and 1.9% in Morogoro.

In Uganda, there are minimal surveillance programmes on milk borne zoonoses. However, surveillance studies are common in the developed world. (read a paper http://www.cdc.gov/mmwr/PDF/ss/ss4901.pdf)

Aspects of occupational health in milk production and processing

Public Health Problems related to milk production and processing embrace working conditions, water, and sewage disposal. In milk production and processing, there are various moments that are of great public health concern. Because of the impoverished economic status of most workers, they tend to work in risky areas of production that are prone to public health problems. There are problems ranging from accidents, food borne illnesses and toxic hazards. Toxic hazards are a relatively new problem to milk production and processing and have attracted a good deal of attention and legislation. Accidents from mechanical equipment far outnumber those from poisoning. Much trouble seems to stem from the unfamiliarity of workers handling potentially dangerous materials in bulk, one important result of which is wrong disposal of the container with serious results.

Food borne illnesses occur as a result of ingestion of raw milk, improper pasteurization, and poor handling/storage leading to contamination. Measures to decrease the threat include: hygienic production practices, proper handling and storage and proper pasteurization.

In developed countries, there are clear and operative laws on preventative occupational health services to workers.

TOPIC 4

Non-infectious contaminants of milk and milk products

In developing countries like Uganda, the production of milk is generally carried out in villages and unorganized barns. The chances of milk contamination are high.

The non-infectious contaminants of milk and milk products occur at levels of milk production and processing. Some of these contaminants include; Chemicals/Toxins/ Drugs (drugs of abuse), Milk additives, Parasites, Environmental (heavy metals) and naturally occurring substances. Therefore, they can be categorized as physical and chemical contaminants.

a) Physical contaminants:

Physical contaminants like dirt particles, hair, leaves, rubber and mettle particles, paper pieces etc can get into the milk at the time of milking. The dirt particles from air even, an unclean udder or body of the cow, unclean utensils and water supply can also contaminate the milk. The hair of the body of the cow can also fall into the milk. The habits of the milker can also add some harmful contaminants like smoking tobacco, which can introduce physical contaminants into the milk.

To reduce this, all the activities of the milker should be scrutinized. The cleaning of the milking equipment should be properly done with a reliable and adequate source of clean water supply. The dairy barns should be maintained regularly and of good condition. The surrounding area of the barn should be kept clean from the waste materials. The milking premises should be free from cobwebs and accumulation of dust particles.

b) Chemical contaminants:

Veterinary, cleaning, agricultural and disinfecting chemicals can contaminate the milk.

i) **Veterinary and agricultural chemicals**: The milking animal treated with any drug or antibiotic can contaminate milk with the residues of drugs. During milking, these chemicals may also be secreted along with milk. During milking, adequate precaution should be taken to minimize the risk of entry of such chemicals into the milk. Milk should not contain more than the safety limit approved by government. Only registered drugs should be used to treat the animal.
ii) **Pest contaminants**: Pests in the milking premises can contaminate milk with their feaces, urine, bedding materials, hair etc. at the time of milking or handling of milk. Therefore, the entry of such pests, for example birds and flies, should be restricted at the dairy farm premises.
iii) **Environmental contaminants**: The environment of the milking area can also cause entry of various chemical contaminants into the milk. The disinfectant sprays in the air, chemical substances in the water, hypo chlorites, heavy metals, activities of neighboring farms, etc. can be proved to very harmful contaminants.
Toxins: Toxins have also been detected in many other commodities. Milk, cheese and other dairy products are also known to be at risk of contamination by aflatoxin M.

The highest levels are usually found in commodities from warmer regions of the world where there is a great deal of climatic variation. Aflatoxin M1 (AFM1) in milk and milk products is considered to pose certain hygienic risks for human health. These metabolites are not destroyed during the pasteurization and heating process. Other toxins may include mycotoxins.

iv) **Cleaning and disinfection**: In the dairy farm, the equipment and the surroundings should be regularly cleaned and sanitized. These activities if not monitored properly can introduce many potential chemical contaminants into milk. Detergents are necessary to clean before disinfection of the equipment for milking purposes.

The detergents should be used with hot water and effective removal of chemicals from the surface of such equipment should also be carried out with hot water.

TOPIC 5

Quality assurance and control of milk and milk products

Quality assurance and control in the milk value chain

Milk safety and quality assurance has become an area of priority and necessity for consumers, retailers, manufacturers and regulators. Changing global patterns of food production, international trade and public expectations for health protection have created a huge demand for food safety. Globally, the incidence of food borne diseases is increasing and international food trade is getting disrupted by frequent disputes over food safety and quality requirements. The components of milk and its physical and chemical properties provide a favourable milieu for the growth and multiplication of microorganisms, thus causing milk spoilage and transmission of disease in humans. Hence, it is necessary to study the sources of microbial contamination during collection of raw milk, processing pasteurized milk, knowing the effect of pasteurization and predicting the shelf life and sensory attributes of refrigerated pasteurized milk and the quality of market milk sold in retail outlets. The analysis used in the study should help to shed some light on the concept of hygienic production of milk. This may be especially useful to professionals in the fields of food safety and quality management.

Globalization of economy and trade has brought integration of domestic markets with the world economy and increasingly stringent food safety and quality standards. With the globalization in the dairy industry shift in milk production strategies is necessary to ensure quality milk production. The quality of raw milk has a direct impact on the quality of product prepared from it. Milk and milk products destined for export need to pass through the strictest quality standards. To achieve this it is necessary to control the quality of milk at the grass root level itself.

Production of clean and safe milk is essential for the safety of consumers and also to make the product competitive at national and global levels. However, the livestock farmers who are mostly spread in villages and are away from access to information technology are by and large uninformed and not quality conscious. This leads to the need to create awareness among the dairy farmers, extension functionaries and office bearers about the measures to be taken for quality and clean milk production.

- Promotion of clean milk production/quality assurance by introduction of hygienic milking at the farm and if possible of machine milking at organized dairies and at collection centres (Community milking)
- Complete automation of collection centres with provision of bulk milk cooler, milk tester, and computerized billing and record keeping at district.

- Promotion of chilling centres in consonance with the rise in production of milk
- Private participation to be encouraged by providing infrastructure such as land and interest-free loans
- In rural areas, propagating the identified village practices for enhancement of quality in outreach villages
- Village level quality assurance and control through strengthening of existing laboratories
- Establishment of certification laboratories
- Awareness capacity building
- Premium pricing policy.

For a proper milk value chain, a systematic approach to quality care is needed, focusing on each individual link in the production chain. Every participant in the dairy supply chain must be responsible in developing this quality system. The authorities are required to continuously monitor the quality of products and production processes to ensure compliance with applicable rules and regulations.

Adoption of the latest and advanced dairy and value addition technology in milk processing can minimize losses; provide better quality, nutrition and more employment opportunities. Dairy technology offers promising options for value addition and resource recovery in terms of consumer food availability and simultaneously improved income-generation for farmers and industry level. There is large scope for the milk industry to grow in view of the globalization and increasing purchasing power of consumers. This will further increase the requirement for trained dairy technologists and researchers. The graduates passing out today do not match the requirements of the emerging market, however. Globalization and a demand-led market necessitate a relook at the content and delivery of curricula and curriculum delivery such that the graduates coming out not only meet the expectations of different stake-holders but can also contribute actively to agricultural growth. For Uganda to occupy a pre-eminent position in the international market, it is important that our graduates also remain in the forefront of developing new technologies and disseminating them to the farming community.

Globalization: World Trade Organization, SPS Agreement, mandate of OIE and Codex Alimentarius as standard-setting organizations

For fundamental changes in the global trade of agricultural and food products, the Uruguay Round of world trade talks resulted in two international agreements. The Agreement on Agriculture of the World Trade Organization (WTO) requires that member countries replace import quotas with tariffs, apply minimum tariff reductions, and reduce subsidies for agricultural goods. A second WTO agreement, the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), creates a framework for addressing the possible use of sanitary and phytosanitary (SPS) measures, commonly known as health and safety measures, as scientifically unfounded barriers to trade in agricultural and food products.

In response to the demand from consumers worldwide for safe food, the OIE is working with relevant organizations to reduce food borne risks to human health due to hazards arising from animal production. The 3rd OIE Strategic Plan (2001-2005) recommended that "OIE should be more active in the area of public health and consumer protection," and noted that this should include "zoonoses and diseases transmissible to humans through food, whether or not animals are affected by such diseases", with the object of improving the safety of the "food production to consumption continuum" worldwide. In 2002, the Director General of the OIE established a permanent Working Group on Animal Production Food Safety (APFSWG) to coordinate the food safety activities of the OIE. The Working Group's membership includes internationally recognized experts from the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the Codex Alimentarius Commission (CAC), and reflects a broad geographical representation. The 4th OIE Strategic Plan (2006-2010) supports the continuation of this mandate, recommending that the APFSWG "continue to work with other relevant organizations, especially the Codex Alimentarius Commission, in reducing food borne risks to human health due to hazards arising from animals".

The Director General of the OIE receives advice from the APFSWG and relevant OIE Specialist Commissions on the activities of the OIE in the area of animal production food safety.

The APFSWG has drawn up a detailed work programme for the development of standards relevant to animal production food safety, covering hazards that arise on-farm and at slaughter, with a primary focus on measures applicable at the animal production level. The APFSWG recognized that the goals of the OIE can only be achieved by working in collaboration with the WHO, the FAO and their subsidiary bodies, particularly the CAC. This is essential to avoid contradictory standards, to address gaps between current standards and to ensure the most effective use of available expertise. To this end, the OIE has strengthened formal and informal relationships with relevant international organizations and expert groups. The APFSWG identified as priorities an examination of the scope to develop joint OIE and Codex standards, to address gaps and duplication in standards, and to develop procedures for mutual recognition of standards where appropriate.

Role and mandates of international organizations

The international trade in animals and animal products has become a sensitive issue for both developed and developing countries by posing an important risk for the international spread of animal and human pathogens whilst at the same time being an essential activity to ensure world-wide food security and food safety.

The OIE has since its founding in 1924, applied a democratic and transparent decision-making process to continuously develop and review international standards for animal health and zoonoses to facilitate trade in animals and animal products. The role of the OIE is also mandated by the World Trade Organization (WTO) as an international reference point for standards related to animal health.

In support of its overall objective of promoting animal health world-wide, the OIE has also launched several other initiatives such as;

- the improvement of the governance of veterinary services within its member countries and territories
- enhancement of the availability of diagnostic and scientific expertise on a more even global geographical distribution. Several trade-facilitating concepts such as country, zonal and compartment freedom from disease as well the trade in disease-free commodities has been introduced to enhance the trade in animals and animal products for all its members including those from developing and transitional countries who are still in the process of enhancing to full compliance with international sanitary standards

Quality assurance and certification schemes

Quality Assurance and Certification Schemes (QAS) can generally be defined as any code of practice, standard or set of requisites, which enables stakeholders of the food supply chain to guarantee compliance with what is declared and to signal this to the end or next user, underlying this statement there are some independent verification processes that add authority to the stakeholders' statement. The stakeholders are the farmers/producers, traders, food processors, retailers, consumers, certification bodies and public authorities.

QAS are schemes implying a voluntary participation and enabling stakeholders involved in the food chain to claim that products or processes fulfil defined quality requirements.

QAS objectives are to;

(1) Standardize and guarantee certain aspects or requirements of the company or production unit (QAS belonging to the family of ISO, BRC, IFS, etc.);

(2) Differentiate and guarantee the product according to some peculiar characteristics of the product, production process or production factors used (e.g., Label Rouge, Calidad Certificada, Heart Label, etc.).

QAS belonging to the first group are set up by ISO or by retailer consortia and are always multinational in scope (they are disseminated over several countries). They are relatively few but present in all EU Member States to different degrees.

These schemes always have a reference regulation (regulated quality), and almost always refer to requirements dealing with the organization of the company, production unit or production process (quality management system, environmental management system, occupational health and safety management system) and not with the product's intrinsic characteristics.

Finally, they tend to certify compliance to legal requirements (rarely) or requirements that go beyond the law (more often) and are almost exclusively adopted in B2B (i.e. not used in communication campaigns for the user).

Generally, it can be said that these QAS tend to differentiate and guarantee products in relation to:

- their biochemical composition;
- their origin and the origin of the raw material used to produce them;
- the production techniques used (in particular their environmental impact, or the use of "traditional" techniques);
- residues of pesticides – whether or not they are traceable – in products;
- the breeding and living conditions of animals;
- ethical aspects of production (workforce conditions).

Good practices

The development of sustainable management systems is a high priority globally as social and environmental aspects of milk production become increasingly important to both consumers and producers. Good practices at farm level with regard to animal health, milking hygiene, animal feeding and water, animal welfare and the environment are essential tools to ensure that both the needs of the food industry and the expectations of consumers are met.

Many dairy companies, co-operatives and countries have introduced on-farm quality assurance programmes aimed at assuring their consumers about the safety of their dairy products. The ‘FAO/IDF Guide to Good Dairy Farming Practice’ provides a generic framework for individual on-farm quality-assurance programmes, focusing on both consumer safety and the image of the dairy sector.

The objective of the document, developed in conjunction with FAO, is to provide a farmer-orientated guide to practices that are achievable all over the world and covering those areas that are essential to manage. The focus is on desired outcomes rather than on specific, prescriptive actions/processes.

The Guide comprises a comprehensive tool kit to improve quality assurance at farm level, thereby enabling dairy farmers to better respond to market incentives, to add value and to adopt new farming methods.

Although many dairy manufacturing plants have developed more sophisticated and automated equipment, safety is still a concern. Good manufacturing practices (GMP's) are industry guidelines that can ensure the manufacture of a safe dairy product during the day-to-day operation of a dairy plant.

The plant must conform to good manufacturing practices as defined by the Food and Drug Administration. This regulation details various standards for floors, walls, doors and windows, lighting, ventilation, water supply, plant cleanliness, disposal of waste, and sanitary personnel practices.

GMP are involved at different levels which include; good hygiene practice at the dairy plants, management of milk collection centres (MCCs), record keeping, cleaning procedures, and proper working habits to minimize the possibility of cross contamination.

GMP implementation seeks to increase the hygienic level at the collecting centres and to maintain the milk quality up to the moment of delivery to the dairy plant. Good practice involves proper selection of appropriate cleaning chemicals and equipment for cleaning the milk equipment and utensils; procedure for cleaning the milk equipment; disinfection of the equipment and utensils; proper sampling for microbiological and chemical analysis; application of blue methylene test and evaluation of the results; training for handling with Lacto scan and pH meter.

Principles of Hazard Analysis Critical Control Point (HACCP) and applications to food safety assurance

HACCP is scientific and systemic system which identifies a specific hazard throughout the food chain i.e. from primary production of milk till it reaches the consumer.

With increasing demand for dairy products worldwide, it is necessary for every dairy industry to adopt HACCP in order to give quality assurance to consumers.

A hazard is any aspect of the production chain that is unacceptable because it is a potential cause of harm or hazard such as a biological, chemical or physical agent in food with the potential to cause an adverse health effect in humans, whether or not it causes disease in animals.

Control points are points in food production starting from the raw state through processing and shipping to consumption by consumers, where the loss of control does not lead to an unacceptable health hazard

Critical control points are those points in food production system where loss of control can lead to health hazards.

Raw and end-products may be tested for the presence, level, or absence of micro-organisms. Traditionally these practices were used to reduce manufacturing defects in dairy products and ensure compliance with specifications and regulations, however, they have many drawbacks e.g. they are destructive and time-consuming, they have slow response, allow small sample size to work with, and they delay in the release of food.

HACCP involves a critical examination of the entire food manufacturing process to determine every step where there is a possibility of physical, chemical, or microbiological contamination which would render food unsafe or unacceptable for human consumption. They identify points are critical control points (CCP).

Principles to HACCP

There are over seven principles to HACCP

1. Analyze hazards
2. Determine critical control points
3. Establish critical limits
4. Establish monitoring procedures
5. Establish deviation procedures
6. Establish verification procedures
7. Establish record keeping procedures

Quality assurance in processing, packaging, transportation, storage of animal products

Milk collection in Uganda is both informal and formal. The informal channel is characterized by: **1**. Lack of established milk collection infrastructure with the farmers delivering milk in aluminium cans or plastic jerrycans to a "pick-up point" established by a trader, transporter or his agent. **2**. Quality control during milk reception is very limited. **3**. Milk is put in 50 litre aluminium cans, which are transported on open pick-up trucks over long distances (up to 400 km) to retail outlets in urban centres. **5.** The evening milk is often not collected. (It is either consumed by the producing household, used to make ghee or boiled, cooled, stored and added to the morning milk on the following day.) Most milk traders and private dairy processors use this system of milk collection and transportation and this allows minimal milk quality assurance.

The formal marketing channel utilizes well-established infrastructure for bulking and transportation of milk. Here, farmers transport warm milk in aluminium cans to the village milk collection centers where it is cooled down immediately (morning and evening). Standard quality tests are carried out before the milk is accepted. Only milk delivered in aluminium or stainless steel cans is accepted. From the milk collection centres, chilled milk is transported in 50L milk cans on open pick-up trucks to the Milk Chilling Plant/another milk collection center or to the satellite collection centres with a larger capacity from where it is transported to the dairy-processing factory in milk tankers of 10,000-20,000L capacity. One dairy processing company, Sameer Agriculture Livestock Limited which took over facilities of the former government Parastatals called Dairy Corporation Limited has signed contracts with some dairy farmers' co-operative unions and companies, giving the latter the responsibility to collect and transport milk from the satellite centres to the processing plant in Kampala.

When received, raw milkis stored in storage tanks until required for further processing. Storage tanks are used for the storage of raw, pasteurized or processed products. The storage tanks must be designed for ease in sanitation, preferably by the circulation-cleaning method. In addition the tanks should be insulated or refrigerated, so that they can maintain the required temperature throughout the holding period.

To allow quality assurance, the storage should be in position to;

1. To maintain the milk at a low temperature to prevent any deterioration in quality prior to processing / product manufacture.
2. To facilitate bulking of raw milk supply, this will ensure uniform composition.
3. To allow for uninterrupted operation during processing and packing.
4. To facilitate standardization of milk quality.

TOPIC 6

Contemporary 'from-farm-to-table' approaches in dairy planning and management

In Uganda, milk production is confined to rural areas and the demand is mostly urban in nature. Hence the milk has to be collected and transported from the production points in the milk shed areas to processing and distribution points in city/towns.

The infrastructure for the rural milk collection is not well developed in most parts of the country except the South western region and to a lesser extent the Central region. The Eastern and Northern regions lack functional rural milk collection centres with cooling equipment. About 200 milk coolers with a total capacity of about 550,000 litres are installed in rural areas for milk collection. Most of these (75%) are found in the South Western region and 15% in the Central region. Chilled milk is delivered to the processing plants and the raw milk markets in insulated milk transport tankers.

To enable good milk quality and safety at farm level, all levels of production chain (feeding, housing, milking practices, disease control, udder health and animal bi-products) have to be properly managed i.e. Quality assurance of milk production through: criteria pertaining to the accommodation and care of livestock; veterinary treatment administered solely by veterinary surgeons working in strict accordance with the GVP (Good Veterinarian Practice) quality code; compulsory registration of all veterinary treatment; established suspension periods — the milk of animals that have received medication is not supplied to the factory; specified system requirements concerning milking shed and milk storage hygiene; established guidelines for cleaning and disinfecting the equipment; statutory environmental standards.

Each animal should be recorded in the Identification and Registration (I&R) system for cattle. The ID code on each animal's ear tag can be used to establish its origin whenever necessary. Assured animal health and health records through: a compulsory certificate of good health for each cow; a disease control program based on continuous monitoring; compulsory registration of all cattle in the I&R system should be in place. For feeding, ensure the cattle a well-balanced diet. The animals should be given supplementary, high-quality, mixed feed. These feeds should be of natural ingredients and do not contain antibiotics, milk yield enhancers, or other synthetic additives to allow high quality and safe milk and milk products.

On the farm milk sample is taken of each animal milking and quality testing to establish: cell counts (associated with mastitis); freezing point (water content of the milk); pH value of the fat; germ count (number of bacteria in the milk); any traces of antibiotics; butyric acid bacteria; visual purity done to allow milk quality and safety.

Handling of milk off-farm should ensure stringent quality control systems at all levels of transportation and processing. HACCP certification systems should provide quality assurance throughout the entire production process, from farm milk to end product. Quality assurance of the production process through: quality management standards; requirements concerning transport from farm to factory; inspection upon arrival of raw milk; hygiene standards for technical equipment; established protocols for the production processes of the various end products need to be proper to allow quality and safe milk and milk products.

All end products are subject to continuous inspection involving sampling and laboratory analysis in accordance with internationally approved research methods. The products are inspected on the basis of the quality standards applied by the European Union. Quality inspection of end products for: composition; additives; microbiological quality; traces of contaminants; appearance, smell and taste (for instance, of butter and cheese) be properly performed.

TOPIC 7

Milk quality testing

Milk sampling and equipment techniques

Equipment/devices used in milk sampling include:

Plunger: It is equipment used to mix the milk or cream to make it uniform in composition throughout the container or can in which in which the product is kept. It is usually made up of stainless steel or aluminium or any metal which will not adversely react with the milk or any other dairy product. It consists of a disc containing several perforations. A long handle is fixed to it at the centre which helps in its to and fro movement in the milk or dairy product.

Dipper: This device consists of a small cup fixed to one end of a long handle and is mainly used to collect the sample from the container. The capacity of the dipper is usually 50 ml.

Tube Samplers: The tube samplers are advantageous in that; 1. A representative sample can be obtained regardless of how long the milk has stood before sampling, 2. A column of milk which represents the milk from top to bottom of the container is collected as sample.

McKay sampler or McKay equity sampler: It consists of two parts and the principle involved in the sample collection is the same as that of tube samplers. The sample of milk in proportion to the quantum of the container is collected.

Milk Sampling

Sampling of milk is requires obtaining an accurate and representative sample of milk for subsequent chemical and bacteriological examination. Strict precautions regarding sterility of the stirrer, sampler, container etc are required for obtaining a bacteriological sample.

The first prerequisite of sampling is thorough mixing of the sample. This can be done with a plunger or stirrer (agitator), operated manually or mechanically in the milk-in-cans or tankers, as the case may be.

Samples may be individual, composite, (mixture of two or more individual lots of milk), drip (representing the entire days supply) etc.

Important point to observe when sampling milk

1. The whole body of the milk from which a sample is drawn should be uniform throughout its composition. The sample of milk drawn from the container must be a truly representative one.
2. The constituent of the milk that is more variable when the milk is standing still is fat. Hence extra care has to be taken to see that it is present uniformly throughout the length and breadth of the container. Other essential factors are

3. When milk is allowed to stand for some time in sample bottles, the fat rises to the top by virtue of its specific gravity. Under such circumstances, the bottle may be immersed in water bath kept at a temperature of 40°C to keep the fat under molten condition before thorough mixing.
4. Violent mixing of milk may be avoided since viscosity of milk will not allow air bubble to rise to the top. Slow but steady churning of fat globules will occur when milk is transported over long distance because of charging of the fat globules with air bubbles.
5. Thorough mixing of milk sample may be ensured by stirring the milk with a long handled plunger if the container is bigger one. If the container is small, the milk can be poured from one to another container or simply shaking it gently.
6. Extra care has to be exercised when sampling is done from frozen milk because it is not uniform in composition. The frozen portion is rich in water whereas the liquid portion is rich in solids. In order to get a true and representative sample from milk, heating to a temperature of 40°C is resorted to in a water bath.
7. Curdled milk samples pose another problem in sampling due to the developed acidity. Hence, they are treated with a strong solution of caustic soda or ammonia (5-10% to the volume of milk) and a correction factor has to be worked out for the quantity of ammonia or caustic soda added.
8. It is necessary to examine the samples as early as possible since physical, chemical and microbiological changes affect the quality of milk.
9. Transport of milk over long distance entails its own problem. In such cases, they have to be preserved by adding suitable preservatives and this kind of addition is permissible only for chemical analysis.

Milk sample preservation

Milk is highly perishable item. The keeping quality of fresh milk is only 5-6 hours, unless proper steps are taken to preserve the quality. The major cause for spoilage of milk is due to the action of micro organisms on lactose yielding lactic and other acids, causing increased acidity milk.

The principle behind milk preservation is only to destroy the micro-organisms or obstructing the microbial growth, so that acidity development is stopped or slowed down.

The methods of preservation may include; 1.by cooling the milk (at refrigeration temperature mesophillic micro-organisms don’t grow); 2.by heating or pasteurization (this kills micro-organisms as majority of them are destroyed at different temperatures); 3. By addition of chemicals (preservatives in small concentrations will inhibit microbial multiplication e.g. sodium carbonate/bicarbonate, formalin/formaldehyde, boric/benzoic acids, etc).

In Uganda, the need to preserve milk normally arises after the evening milking when the farmer may not be able to deliver the milk to the milk collection centres or other buyer. Farmers have very few options for preventing spoilage of milk at farm level. Cold storage equipment would be necessary for storing milk for long hours before marketing. Small-scale farms may need equipment such as deep freezers while large farms may need coolers. In the South Western milk-shed, milk preservation at farm level is still a big problem. About three quarters of the farms do not have any means for milk preservation while the other one quarter relies on heat treatment to prevent spoilage of the milk.

Common milk tests

Rapid platform tests
These are performed to reject the poor quality milk at collection centres to prevent the mixing of poor quality milk with good quality milk

Organoleptic tests

- Test for colour, flavour and taste

Clot on boiling test

- It indicate keeping quality of milk and susceptibility of milk to heat processing
- 5 ml milk in test tube and boil for 5 min
- Sample of milk with high acidity and poor heat stability clots on boiling

Sediment test

- Either done by centrifugation or filtration

Alcohol test

- Also use for determining the keeping quality of milk
- 5 ml of milk in tube + little alcohol from sides of tube
- Positive test is indicated by flakes formation

10 min Resazurin test

- It provides a rapid measure of the sanitary condition of milk
- Resazurin dye imparts blue colour to fresh milk
- If milk changes from blue to purple then milk is accepted but pink and white colour milk are rejected

Lactometer reading

Other tests for quality control of milk
Test for mastitis

- California mastitis test
- White side test

Test for antibiotic residues

- Agar disc diffusion method

Test for pasteurization: Phosphatase test

Conclusion

Now the student should be able to;

Plan and investigate milk quality and safety; Apply and incorporate the principles of milk quality and safety systems in a real application; Apply the principles of quality assurance system to control and assure the quality and safe of milk products; Understand government regulations related to quality assurance system required for the manufacture and sale of milk products; Identify and compare intrinsic and extrinsic quality characteristics of milk and milk products; Apply quality management tools to collect, organize, analyze and evaluate data; Describe and compare the principles of quality management systems (ISO 9000:2000 series; HACCP and HAS) and apply them in a milk processing system

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