

Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers

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Engineering Milk Production and Processing Systems



Israel is one of the world's top diary producers with the aid of effective breeding policies and technology. Israel is the global leader of milk production in the world ranking the *highest production of milk per cow*. In 2021, Israel recorded a total of 12,000 kg average milk production per cow. Israel's dairy industry is considered one of the most advanced in the world

On the other hand, Kenya is the leading milk producer in East Africa. Dairy is the largest agricultural sub-sector in Kenya in terms of income and employment creation contributing 4% to overall GDP. Currently., the country has around 6.1 million dairy cows which produce 607 kg/year/cow of milk and a total annual production around 3.7 million kg of milk.

DEAR READER

Welcome to KeSEBAE Newsletter.

A fortnightly Newsletter touching on topical issues affecting our environment.

KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE)

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Dairy farmers in Kenya have basic feeding systems such as free grazing, semi zero-grazing with improved pastures and zero-grazing.

Some of Israel's top companies in the dairy sector include: Afimilk, ABL Technologies Ltd, and Armenta.

Kenya's dairy industry is a private sector driven. Milk is majorly produced by smallholder dairy farmers who account for 56% of the total output. The sector has an estimate of 1.8 million smallholder farmers who comprise of 80% of milk producers. The remaining 44% of milk output comes from large commercial farmers.

The volume of marketed milk in Kenya increased by 2.1 per cent from 668.2 million litres in 2019 to 682.3 million litres in 2020. (*Kenya National Bureau of Statistics- Economic Survey*). The industry is constrained by low-productivity at farm level, seasonal milk production, milk quality fluctuations, and a huge knowledge and skills gap.

1.0.Unique Milk Production Techniques in Israel

Milk production begins at the farm where dairy cattle are reared. This implies, that milk production is a cumulative result of proper dairy management. As observed in afimilk, the largest dairy farm in Israel.

Israeli farms owe their success to impressive technological advancements. These technological advancements include detailed feed analysis, sophisticated farm management techniques and use of farm cooling systems to keep the cows at healthy temperatures.

In spite the fact that the country has what may be considered as unfavourable conditions for farming such as excessive heat, humidity and limited resources. Israel's dairy industry is considered one of the most advanced in the world. The total milk production in Israel is about 1.6 billion liters per year. The advanced technologies including computerized milking and feeding systems, cow-cooling system and milk processing equipment, combined with unique farm management techniques have led to Israel's major success.



Figure 1.1.: Israeli Milking System Source: Alamy

Approximately, Israel's dairy herd is 100,000 cattle. Israel has over 750 dairy farms. There are two farming systems: Kibbutz, which are largely farm units, and the Moshav, which are family herds organized as a cooperative society. All dairy production is overseen by the *Isreali Dairy Board*, owned by the government of Israel the major processing companies and the dairy farmers themselves.

Israeli dairy cows do not graze due to unfavorable conditions. Rather, herd diet is based on scientific, online feed analysis and calculated feed rations for the highest nutritional value, production rates and economic efficiency.

The Kibbutz hold an estimate of 163 dairy farms while Moshav has 583 dairy farms. The Kibbutz produces 58% of the total milk while Moshav produces 41% of the total milk.

2.0.Training of Dairy Farmers

Israel has a dairy school called The *Israeli Dairy School* which provides dairy professionals with practical Israeli techniques for successful dairy herd management. The school is composed of a team of sixty (60) dairy experts who help train companies and farmers on advanced practical dairy farming in extreme conditions.

The Israeli dairy farmers are well trained, embrace technology, always seek innovation and demand individual animal information. They rely on automated systems and use management software that keep records. They are also willing to share farm data and results.

Israel has thereby experienced tremendous success in dairy farming. One of their biggest leverages is they take proper care of their cows. As seen in Israel's experience, profitable dairy farming is a combination of:

- Genetics and breeding
- Nutrition and feeding

- Milk quality and Udder health
- Herd health
- Cows Welfare
- Good herd management and planning

2.2.Israeli Dairy Cows – Genetic Program

All breeding is by artificial insemination and 95% is done by Sion. The Israeli Herd and Sion is the basis for genetic improvement of the strain.

Israeli cross-bred sheep combines the positive qualities of the Awassi and German East Friesan breeds. This has resulted in produce of an average of 450 litres of milk annually.

2.2. Heat Detection

Pedometers on cows are used for heat detection and more efficient breeding. Using the latest technology, Israel is able to get better pregnancy rates. Peaks in activity indicate that a cow is on heat.



Figure 2.2. Pedometers on cow's neck Source: Dairyschool.co.il

2.3. Optimal Milking Routine and Udder Health

A full hygienic milking routine is one of the cheapest and most effective ways for health udders and more milk. Milking requires cooperative effort between the cow, the operator, a properly functioning milking machine and a good milking routine.

2.4.Nutrition and Feeding

Quality forage and reasonable cow comfort is another key success factor in any conditions. The ensilage process and technology is highly maintained and provide a high quality silage. Silages are packed and stored only in concrete bunkers. A quality check for silage is done before and after exposure.



Figure 2.4. Silage management in Israel farm Source: Benison Media

2.5.Heat Stress Management

Cooling Cows improve cow's welfare and production sustainability. Cooling is done by showering and ventilation in the holding pen of the milking parlor.

The equipment should produce large water droplets that effectively soak the cow's hair coat and reach the skin. Fans are employed to remove the air containing the evaporated water.



Figure 2.5. Cow cooling using sprinkler showers Source: Avidity Science

2.6.Dairy Herd Management Tools

In Israel's modern farms, herd management program is widely used. A good herd management program is accurate and reliable information systems that support the right decision-making. The tool supports a variety of features, from heat detection and feed behaviour, to health and welfare monitoring, using scalable software modules analysing real-time cow behaviour.

The three main Israeli herd management companies are afimilk, SCR now Allflex (Merck) and ENGS.

Milk Production	Ð	Health	0	🙆 To do today 👩 b	Û
Milk last session Milk previous day Cows milked last session	5485 [10666 [298	Maxtitis Digestion Problems Ketouls Fresh cows to check Anestrus Non-specific health report	1 2 0 10 1 1 7	To dry today Due calving Sorted Animals For pregnancy check	14 34 31 3
Fat % last 24H Protein % last 24H	Ø 1.0%	Suspected abortion	9 @ 1	Faults today	2
Animals Inventory	Cover Helfers @	G Groups	Ø	Un-Assigned lags Not identified in Milking Wrong Group	0
Pregnant 74 Open 226 Dry 44	(\bigcirc)	Groups Comfort Nutrition alerts	1 © 0		

Figure 2.6 Dairy herd management tool user interface Source: Afimilk

3.0.Milk Processing Systems

The process chosen to produce milk can be standard, clean, ultra clean and aseptic. Standard and clean processes produce milk with a shelf life of 10 to 14 days, while aseptic processing produces milk with a shelf life of upto 30 days. The type of components such as valves, pumps, etc, as well as the filling, packaging, storing and sterilizing technologies used, vary depending on the type of process chosen. Different types of milk: fresh milk, UHT milk, ESL milk, sterilized milk, low fat milk, skimmed milk, condensed milk. Milk is collected from the farmers and transported to milk plants for processing into mass market milk and other dairy products such as cream, butter, cheese, casein, yogurt etc.

3.1.Milk Reception Units

Milk is produced constantly at the farmers' facilities where the cows are milked then transported on tank trucks and delivered to the different dairy and milk plants. In the milk reception units, milk is measured and tested, air is eliminated and the milk is cooled before further processing or storing.



Figure 3.1. Milk Recption Unit on a Milk Processing Firm in Kenya Source: Nation

3.2.Milk Storage Units

Milk is then stored into tanks or pumps or directly into the processing line from the milk reception units. Milk is stored in tanks or silos along different phases of the processing line, these inter processing tanks are automated into the processing line.

Aseptic milk storage is required if the milk has followed an aseptic process.

Storage systems can vary from a very basic system that is manually handled, to one that is completely automatic and combined alongside CIP systems and sterilization units.

3.3.CIP or SIP

Clean-in-place (**CIP**) is a method of cleaning sanitary process lines, vessels, and equipment commonly used in hygienic process plants.

3.4.Milk Sterilization

The process of reducing the microorganism is called sterilization.

Different sterilization processes are used depending on the amount and type of microorganism that need to be killed and the shelf life of the product we want to achieve. The different processes used are: pasteurization, UHT, HTST or filtration.

For the production of fresh milk, pasteurization is used for the production of ESL milk, UHT or instead several filtration systems are employed. The most marketable fluid milk nowadays is either UHT or HTST.

3.5.Pasteurization

It is the process of treating milk at a high temperature. And then cooled so as to extend its shelf life and reduce microbial growth while retaining the maximum natural qualities possible.

HTST (High temperature short time)

Milk is put through a continuous process of very high temperatures for a short time. This process conserves milk quantities better than more aggressive processes such as UHT or aseptic processing. The disadvantage of this method is that it produces milk with a shorter shelf life.

UHT (Ultra High Temperature)

This the most commonly used method used to sterilize the milk further after pasteurization in the industry.



Figure 3.5: Pasteurization Cycle Source: Quora

This process consists of continuous sterilization process where milk is heated at very high temperatures then cooled numerous times. The aim is to kill all micro-organisms and prolong milk shelflife. ESL (Extended Shelf Life) Milk is fresh milk with an extended shelf life.

3.6.Milk Standardization – Cream Separation

The fat content of raw milk varies depending on the type of cow, cow feeding, age, timing etc. Due to this, milk follows a standardization process where either raw milk or even sterilized or pasteurized milk is separated into cream and skimmed milk by the cream separation machines. Part of the cream is added back into skimmed milk in exact proportions in order to precisely define the fat content of the milk and standardize it.

The rest of the cream is processed to produce products such as cream, condensed milk, butter etc using various technologies such as evaporation, mixing, drying etc



Figure 3.6: Milk Standardization Process Source: MilkyDay

3.7.Mixing

At this process, milk can be enriched with vitamins, calcium or other types of ingredients. These should be mixed and blended in batch or continuous processes in mixing units.

3.8.Homogenization

This process is done by machines called homogenizers, whose objective is to prevent the cream from separating from the rest of the liquid once the milk is stored.

3.9.Milk Filling and Packaging technologies

Once the product manufacturing process is finished, the milk passes to the filling and packaging process. Milk can be packed into different types of packages: carton, glass, pouches, PET bottles etc.

Sterilized milk that needs to have a long shelf life should be filled and packed using aseptic technologies.



Figure 3.9. Milk Packaging at Brookside Milk Processing Plant Source: Nation

4.0. Innovations in the Dairy Farming Sector in Kenya

4.1.The Mazzi Milk Jug

The Mazzi is a 10-liter reusable plastic container. It has a wide mouth that allows farmers to use both hands during the milking process thereby increasing output. It has a detachable black funnel that enables farmers to identify if the cow has an udder infection, limits contaminants from entering and prevents spilling. The stackable lid allows for easy transport to purchasing centers and for hassle-free cleaning once emptied.



Figure 4.1.: A farmer using the Mazzi jar during milking Source: Huffpost.com

In Kenya, 80% of milk produced by small scale farmers is lost during delivery through spilling and spoiling. The standard pail used in milking by dairy farmers are often kicked over during milking and the inefficient shape would invite contaminants that can spoil the milk.

The Mazzi was developed by the Bill and Melinda Gates Foundation working with Global Good and Heifer International.

The Mazzi is an efficient and inexpensive jug that can transport milk on long journeys and help prevent it from curdling.

4.2.Easy Ma 6.0

Easy Ma 6.0 was introduced in the Kenyan Market in 2014. It is a digital scale and supply chain system. It was developed by Kenyan tech agencies in collaboration with USAID funded programmes.

The process of Easy Ma 6.0 starts with farmers weighing their milk at designated buyer collection centers.

Producers afterwards get an automatic receipt as well as an immediate advance. This system ensures that farmers receive fair compensation for the quantity of product they supply.

In addition to providing security in payments, Easy Ma 6.0 also enhances transparency and good record keeping within the dairy industry. More than 22,000 Kenyan dairy farmers now have access to farm extension services, financial products and even livestock insurance through Easy Ma 6.0.



Figure 4.2: Citizens observing the EasyMa 6.0 system during a site visit Source: Spore

4.3.My Fugo

My Fugo is a new software application as a Service (Saa) based app solution that allows farmers to capture and record livestock data with the aim of improving yield and profitability.

The app helps famers monitor his cows throughout the day enabling him to tell what time the cow will be on heat for it to be served at the right time.



Figure 4.3: A Farmer Showing a Visitor The Smart Collar On The Cow's Neck Source: Myfugo

Smart Cow Collar

The Smart Cow Collar device is a tag placed on the animal that is used to accurately project the reproductive cycle. It enables the farmer to know the exact time when the animal is on heat. This information is then sent to the farmer's laptop or phone in real-time through My Fugo app after every 30 minutes hence helping farmers get alerts to changes in animal health and heat patterns.

The app also helps farmers in keeping their records digitally. This data helps deliver insights and analytics that farmers need to optimize the productivity of every cow.

Farmers also get information through WhatsApp or through USSD code messages after being entered into the portal base.

5.0.Lessons the Kenyan Dairy Sector Can Learn from Israel

Israel is small country of with an area of 22,145 km² while Kenya has an area of 581,309.0 km². The total milk production in Israel is about 1.6 billion liters per year while Kenya produces 6 billion liters per year. Israel ranks the highest in the world in milk production per cow.



Figure 5.0. An extracted map of Kenya (Orange) and Israel (Green) Source: Wikipedia

This shows an underperformance in the Kenyan dairy sector which can be improved through education and better farming practices.

5.1.Central Management

Israel depicts a carefully planned strategy on optimization of dairy farming as deduced from their results and patterns of milk production and processing. Israel's greatest leverage is the *Isreali Dairy Board*, or in other words, central management. Dairy farming in Israel is centrally managed independent of the fact that there are two different farmer types that is the Kibbutz and the Moshav.

The Israeli Dairy Board manages the Israeli Dairy School. This implies that the information each farmer obtains from the dairy school stems from one source.

The Israeli Dairy Board also manages the milk processing factories. Therefore, they monitor the delivery and distribution of milk per company.

In Israeli dairy farms, **herd management program is widely used.** These programs are managed overally by the board. This enables them to monitor performance from regions to individual farmers.

5.2.Education

Dairy farmers in Israel are equipped with knowledge and skills that sharpen their wit in the farming hence realize better outcomes. This education is centrally shared therefore each and every farmer gets the opportunity to learn.



Figure 5.2. A Farmer Receiving A Certificate For Receiving Training From The Israeli Dairy School Source: dairyschoool.co.il

This is not so in Kenya. The advantage of education is left for the elite farmers and the farmers who practice dairy farming large scale. These few farmers are actually self-taught. In as much as extension services from both Government and the private sector has led to the increase production of milk from the dairy farms in the country, for us to achieve optimal levels of production, educating farmers must therefore be very well intentionally prioritized and structures.

The Israeli farmers, are continuously taught throughout the year. The learning is a continuous process. Visits from the Government officials from Israeli to the different farmers are scheduled and frequent. This is to ascertain that the farmers are applying the knowledge they learn and assist them with anywhere they would need help.

5.3.Cow Health

Milk processing in both Kenya and Israel are almost the same as they both use similar technology. Israel however puts greater weight on managing the cow. This is because the cow's health is vital to milk production. The quality of milk can be attributed almost entirely to the cow's state of health. This is done through ensuring the cow feeds on the best dietary programmes, quality feed, cooling the cow as Israel is in a desert area and cow udder management.

In Kenya, most farmers feed their cows on basic fodder such as grass, maize stalks and Napier grass.

If the country seeks to improve the milk production in Kenya, each cow in each farmer's care must be well attended to.

This can be achieved through distribution of supplements and other innovative feed that can

drastically improve the cow's health hence its milk production.

Genetics in cows is also a contributor to milk produced in volumes. Kenyan dairy sector should improve further on the quality of the breed of the cow for increased milk production. This can be done through investing in genetic research and benchmarking from other successful countries.

5.4.Farm Category Arrangement

In Israel, there are two farming systems: Kibbutz, which are largely farm units, and the Moshav, which are family herds organized as a cooperative society. These two farm types are managed and owned by the government of Israel through the Israeli Dairy Board.

Borrowing a leaf from this, Kenyan dairy farming sectors can organize the dairy farmers in two farm types. There already exists a differentiation in farmers by scale of farms that is: large scale and small-scale dairy farmers. Layering on this, these farmers can be divided and arranged in terms of location, sub-county, counties and region.

The most important reason for this arrangement can be for the purpose of education. This creates a channel that ensures every local farm is exposed to information that they can use to improve their milk production.

Later on, as the strategy is put to work, it is strengthened and the same channels can be used for distribution of products and also delivery to milk processing companies. **KeSEBAE**

2022



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KEY DATES:

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The JEAE Editorial Board wishes to invite interested researchers with complete work in any relevant topic, to submit their papers for publication in the next editions of the Journal.

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Priority in the selection of articles for publication is that the articles:

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- c. Have not been previously published elsewhere, or, if previously published are supported by a copyright permission
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- g. Manuscript should be single-spaced, under 4,000 words (approximately equivalent to 5-6 pages of A4-size paper)
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Please transmit the same to the Editor: Ezekiel Oranga via Email: <u>info@kesebae.or.ke</u>

NOTE: A payment will be made to the author of each selected article

KeSEBAE-Young Engineering Chapter Upcoming Event WEBINAR

Title: Enhancing your Career through Professional Registration II

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Member	2,000	1,000	2,000
Ass.Member	1,000	1,000	2,000
Aff.Member	500	1,000	2,000
Student	300	100	-

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