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Scientific Guidelines to Increase Milk Production: Understanding the Factors and Strategies

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Abstract

Milk production is one of the most crucial components of dairy farming, directly impacting farmer incomes and the supply of dairy products to the market. This article provides a comprehensive overview of the scientific factors that influence milk yield and outlines practical strategies to enhance productivity. From breed selection and lactation cycles to nutrition and milking frequency, we explore how farmers can apply knowledge-driven practices to maximise milk production. The article also emphasises the importance of animal welfare, feeding management, and genetic improvement. By understanding and managing these interconnected factors, dairy farmers can significantly boost milk yield and ensure sustainable dairy operations.

Keywords: milk yield, quality, dairy farming, nutrition

Introduction

India, often hailed as the "Oyster" of the global dairy industry, continues to lead the world in milk production, contributing 239.30 million metric tons in 2023–24 (BAHS, 2024). This represents nearly 24% of global output, a distinction achieved through consistent growth and strategic interventions across the dairy sector (Bihola *et al*., 2025), yet many dairy farmers especially in rural and small-scale setups struggle to maximize milk yield. While it is easy to blame poor output on breed or weather conditions, milk production is actually influenced by a variety of scientific factors. These include the genetic makeup of the animal, stage of lactation, feeding practices, temperature, and even how and when the animal is milked. In this article, we decode the science behind milk production and provide practical strategies that farmers can adopt to boost their herd's productivity.

Understanding the Factors That Affect Milk Yield

One of the most significant factors affecting milk production is the species and breed of the animal. Buffaloes generally produce more milk than cows, and both outperform smaller ruminants like sheep and goats. Within cows, indigenous breeds such as Gir, Sahiwal, and Red Sindhi tend to yield between 1500 to 2500 liters per lactation, while others like Hariana and Ongole average between 1200 to 1500 liters. Even within the same breed, individual animals can show large variations in productivity depending on their strain and genetic makeup.

The stage of lactation also plays a key role. Milk yield usually peaks within the first two months after calving, followed by a gradual decline of 6–8% each month. A persistently high milk yield beyond this peak can be maintained through proper feeding and care. Another critical element is the frequency of milking. Milking a cow three times a day can increase milk production by 10–25% compared to twice-daily milking. Increasing it to four times a day can yield an additional 5–15%.

Milk production also declines during pregnancy, especially after the fifth month. If a cow is mated too early—before 85 days after calving—it may result in a shorter lactation period and a rapid fall in milk yield after the 20th week. Similarly, a cow's age influences yield. Cows tend to increase their milk production with each pregnancy until they are about seven years old, after which the increase levels off. During estrus or heat, cows often experience a temporary reduction in milk yield. This can be minimized by confining the animal and avoiding any stress. The dry period, usually around 60 days before the next calving, is vital for the animal to replenish its body reserves and regenerate milk-secreting tissue. Skipping or shortening this dry period can affect

productivity in the next lactation cycle (Aleli, 2024).

Environmental factors, especially temperature and humidity, can greatly affect milk production. While temperatures between 40°F to 75°F do not cause much stress, higher temperatures reduce feed intake and increase the animal's body temperature and respiration, leading to reduced milk yield and a decline in milk quality. High humidity worsens this problem by preventing the animal from efficiently cooling itself through sweat or evaporation.

Scientific Strategies to Improve Milk Production

One of the most powerful tools for increasing milk production is genetic improvement. Selecting high-yielding breeds that are well-adapted to local climates and feeding conditions is a critical first step. Breeds like Holstein Friesian and Jersey are known for their high milk yield, while indigenous breeds like Sahiwal and Gir offer better heat tolerance and disease resistance. Crossbreeding between indigenous and exotic breeds can combine the best traits of both. Artificial insemination using semen from high-yielding bulls helps ensure that the next generation of animals has greater genetic potential.

Nutrition is a fundamental factor in improving milk production in dairy animals, as it supplies the essential components for milk synthesis and supports the overall health of the cow. A balanced diet containing adequate amounts of protein, carbohydrates, fats, vitamins, and minerals is critical for optimizing both the quantity and quality of milk. Proper concentrate feeding involves maintaining an appropriate forage-to-concentrate ratio and ensuring optimal levels of non-fiber carbohydrates (NFC). NFC should typically range from 20% to 45%, with 40–45% suitable for diets containing less than 60% forage. Grain intake should not exceed 7 pounds per feeding to prevent rumen acidosis, digestive disturbances, and a drop in milk fat content. Nutritional requirements must be calculated to meet both maintenance needs and milk production demands, including fat content and gestational needs. Based on these requirements, the ration should be carefully formulated. Dry matter intake from roughage should generally range between 1% and 2% of the cow's body weight. A typical adult dairy cow should receive around 6 kg of dry fodder and 15–20 kg of green fodder daily. The green fodder should ideally be offered in a 1:3 ratio of legumes to non-legumes.

The diet must include high-quality roughages—such as berseem or lucerne—and concentrates derived from grains and oil cakes. During fodder-scarce periods, fermented feeds like maize or sorghum silage can provide vital nutrients. In addition to macronutrients, dairy cows require essential minerals such as calcium, phosphorus, and common salt, along with vitamins A, D, and E. Clean, fresh water should always be available, as milk consists of approximately 87% water. Scientific feeding becomes especially crucial for high-yielding cows. While roughages may suffice for animals producing up to 4–5 kg of milk daily, an additional 1 kg of concentrate should be added for every extra 2 kg of milk produced. Feeding should be divided into four intervals, spaced six hours apart. To prevent digestive issues, concentrate feeding should follow roughage consumption. Additional nutrition during late lactation and the dry period is important to replenish body reserves and ensure a productive start to the next lactation cycle. Two weeks before calving, introducing challenge feeding—gradually increasing concentrate intake by 300–400 g per day—prepares the cow for higher milk output. The goal is to reach 500–1000 g of concentrate for every 100 kg of body weight. After calving, increase concentrate by 500 g daily during the first two weeks of lactation until the cow reaches peak yield, usually by the second month. Feed should be offered on a free-choice basis during this period

Stage of lactation	Quantity of green grass to be give (kg) for animal weighing			Concentrate (kg)
	250 kg	300 kg	350 kg	
Dry cow	25	30	35	▪ For non-pregnant cows, no concentrate is required. ▪ Pregnant cows should be fed an additional quantity of 1.5 kg of concentrate from the 7th month of gestation ▪ In case of a dry cow, allowance up to 1 kg of concentrate can be given if the condition of the cow is poor or the fodder quality is inferior.
Milch cow	25	30	35	▪ 1.0 kg for every 2.5 kg of milk of average 4% fat percentage, in the case of buffalo, 1.0 kg for every 2.0 kg of milk produced.

Managing Stress and Milking Practices

Dairy animals are highly sensitive to their environment and management routine, and any disruption can directly affect their milk production. Stress can inhibit the natural let-down reflex, which is primarily governed by the hormone oxytocin. Oxytocin is released into the bloodstream in response to stimulation—such as washing the udder or suckling by the calf—and causes the smooth muscles around the alveoli in the udder to contract, pushing the milk toward the teat cistern.

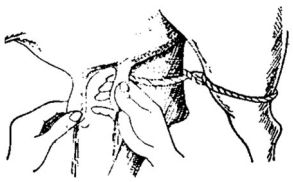
However, oxytocin has a very short action span, lasting less than one minute, as it is rapidly destroyed in the bloodstream. Therefore, milking must begin immediately after let-down and be completed within 5–7 minutes to extract the maximum amount of milk (Bruckmaier and Blum, 1998). Delay or interruption during this time window reduces milk flow, and a second stimulation cannot fully replicate the effectiveness of the first. Moreover, any residual milk left in the udder can act as a medium for bacterial growth, increasing the risk of mastitis a painful and production-limiting infection.

The release of adrenaline, a stress hormone, also poses a serious threat to the milking process. If the cow is disturbed—by loud noises, unfamiliar handlers, rough treatment, or environmental discomfort—adrenaline suppresses oxytocin release, effectively blocking milk ejection and significantly lowering yield. Hence, a calm, predictable, and stress-free environment is essential during milking.

Consistency in routine is key. Animals should be milked at the same time every day, ideally by the same person, using familiar and gentle methods. Before milking, the udder and teats should be washed gently, and the first few streams of foremilk from each teat should be squirted into a strip cup. This not only helps detect early signs of mastitis, such as clots or discoloration, but also flushes out any contaminants from the teat canal.

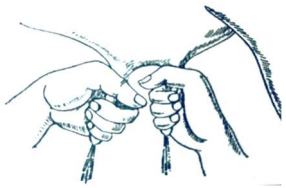
During milking, different techniques can be employed as shown below:

Stripping



It is performed by firmly holding the teat between the thumb and forefinger, then drawing downward while applying pressure. It is often used in small cows with narrow teats but is less efficient and more time-consuming.

Full-hand milking or fisting



It involves grasping the entire teat with all five fingers and rhythmically squeezing against the palm. This method closely mimics the natural suckling action of a calf and is superior to stripping, especially for cows and buffaloes with larger teats. It allows faster milking and exerts even pressure on the teat, reducing the chance of injury.

Knuckling

In this, the thumb is bent against the teat. Though sometimes used toward the end of milking or for very small teats, it can cause injury to the teat tissue and should not be a routine practice.

Machine milking

In larger dairy operations, machine milking offers an efficient and hygienic alternative to hand milking. When properly maintained, milking machines can extract milk quickly without causing injury to the udder. In addition to extracting milk, the machine also gently massages the teat, preventing the build-up of blood or lymph congestion.

Other essential practices to reduce stress and enhance milking include (de Passillé and Rushen, 1999)**:**

- Washing animals twice daily to keep them clean and comfortable
- Cleaning dung from the shed at least three times a day
- Avoiding direct sunlight and allowing animals to graze freely for at least a few hours daily
- Preventing mosquito and insect infestation in sheds
- Avoiding rough handling, loud noises, or frequent changes in handlers

- Regular deworming, as internal parasites negatively impact nutrient absorption and milk yield.

Ultimately, animal comfort, emotional calmness, hygiene, and timing are all crucial factors that influence successful milk let-down and overall productivity.

Conclusion

Increasing milk production is not about a single technique or miracle solution—it is the result of careful planning, scientific management, and understanding the biology of dairy animals. By focusing on genetic selection, balanced nutrition, proper milking techniques, stress reduction, and reproductive health, farmers can unlock the full potential of their dairy herds. A well-managed cow, with the right feed, care, and environment, is capable of producing high-quality milk consistently. With knowledge-driven interventions and a commitment to animal welfare, India's dairy farmers can achieve higher milk yields and build a more sustainable and profitable dairy sector.

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