

Scientific Management of Dairy Animals for Higher Milk Production

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Abstract

Higher milk production depends on coordinated management of genetics, nutrition, housing, reproduction, udder health and milking practices rather than on any single input. Scientific dairy management begins by matching feed and care to the animal's physiological stage. The transition period around calving is particularly important because metabolic stress during these weeks can influence milk yield, fertility and disease risk throughout lactation. Balanced rations, adequate effective fibre, mineral supplementation and unrestricted clean water support rumen function and milk synthesis. Comfortable housing, heat-stress reduction, clean bedding and sufficient lying space improve feed intake and welfare. Consistent milking routines, teat hygiene and early mastitis detection help protect udder health and milk quality. Reproductive efficiency must be monitored through heat detection, timely insemination, pregnancy diagnosis and management of postpartum disorders. Records of milk yield, body condition, feed intake, disease and breeding allow farmers to identify low-performing animals and management bottlenecks. Scientific management therefore aims to express the animal's genetic potential while maintaining health, fertility and longevity. Sustainable milk production is achieved when higher yield is accompanied by efficient feed use, lower disease incidence and better welfare.

Keywords: Dairy management, milk production, balanced feeding, udder health, heat stress, reproductive efficiency

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Introduction

Milk yield reflects the interaction between genetic potential and the environment in which the dairy animal is kept. A high-producing cow or buffalo cannot maintain performance if feed quality, water, housing, health or reproduction are poorly managed. Scientific dairy management therefore uses measurable targets for nutrition, body condition, milk quality, fertility and disease rather than relying only on visual impressions. The aim is to create a stable daily routine in which animals can eat, drink, rest, ruminate and express normal behaviour with minimum avoidable stress. Management decisions should be based on the animal's stage of production, because requirements change markedly from the dry period to calving, early lactation, peak milk and late lactation. Regular

observation remains essential even on farms using automation, since changes in appetite, rumination, manure, gait, udder condition or social behaviour may be the first sign of a developing problem. By combining these observations with milk records, feed information and veterinary findings, farmers can identify weaknesses before they become expensive production losses. Scientific management is therefore not a single technology; it is a coordinated system that links nutrition, comfort, hygiene, reproduction, disease prevention and records into one practical programme.

The objective is not maximum milk at any cost. Profitable production requires persistent lactation, acceptable fertility, low involuntary

culling, good welfare and efficient use of feed and labour. An animal that produces a very high peak yield but repeatedly suffers mastitis, lameness, metabolic disease or infertility may be less profitable over its lifetime than an animal with slightly lower peak production but better health and longevity. Management should change with age, parity, stage of lactation and season because the needs of a dry animal, fresh calver and mid-lactation animal differ. First-lactation animals also need special attention because they are still growing and may be socially displaced by older cows at the feed bunk or resting area. Herd grouping can help provide rations and space according to physiological need, but groups should not be changed so frequently that social stress reduces feed intake. A useful dairy plan sets clear targets for milk yield, body condition, disease incidence, reproductive performance, culling and calf growth, and reviews them regularly. The purpose of targets is not to punish individual animals or workers; it is to reveal where management can be improved and whether a change in feeding, housing or health care is producing the expected benefit.

Transition Period and Fresh-Animal Care

The three weeks before and after calving are a high-risk period because feed intake, hormone balance, mineral metabolism and immune function all change rapidly. Feed intake often declines before calving while energy demand rises sharply after calving as milk production begins. Severe imbalance can predispose animals to ketosis, fatty liver, displaced abomasum and weak immune function, while disturbances of calcium metabolism can contribute to milk fever and reduced muscle function. Close observation of appetite, rumination, manure, temperature, attitude and calving progress is especially valuable during this period. Animals should have a clean, dry and well-bedded maternity area that allows observation without unnecessary disturbance. Calving assistance should be provided only when needed and with good hygiene, because excessive or unclean intervention can increase trauma and infection risk. After calving, the placenta, uterus, udder and general demeanour should be checked and any abnormal discharge, fever, weakness or

poor appetite investigated. Fresh cows should be encouraged to drink and eat promptly, and movement to another group should be managed carefully to avoid additional social stress. The transition period has a disproportionate influence on later milk yield and fertility, so small management improvements during these weeks can have effects throughout the lactation.

Dry-cow rations should maintain appropriate body condition and provide adequate effective fibre, protein, vitamins and minerals without promoting excessive weight gain. Animals entering the dry period already over-conditioned are more likely to mobilise large amounts of body fat after calving, whereas very thin animals may lack reserves for early lactation. Body condition should therefore be monitored well before calving rather than corrected at the last moment. Feed should remain fresh and palatable, with sufficient bunk space so timid animals can eat without prolonged competition. Major ration changes should be introduced gradually to support rumen adaptation. After calving, concentrate is usually increased progressively as dry matter intake improves, while good-quality forage remains important for rumen function. Fresh animals should be checked systematically for retained placenta, metritis, mastitis, milk fever, ketosis, dehydration and poor appetite, and any abnormality addressed early under veterinary guidance. Daily checks are more useful when they follow a consistent protocol and findings are recorded. Farms can define simple action thresholds, such as a sudden fall in feed intake, absence of rumination, fever, abnormal milk or delayed return to normal behaviour. Early intervention is often less costly and more successful than treatment after clinical disease becomes severe. Transition management should also include comfortable flooring and adequate resting time because pain, lameness or overcrowding can further depress intake at the time when nutrient demand is increasing.

Balanced Feeding for Milk Synthesis

Energy and protein supply should match milk yield, body weight and stage of lactation. Forage quality is central because digestible fibre supports rumen health, saliva production and feed intake. Concentrates can increase nutrient density, but excessive rapidly fermentable carbohydrate raises the risk of

ruminal acidosis, inconsistent manure, reduced cud chewing and milk-fat depression. Rations should therefore balance fermentable energy with physically effective fibre and should be mixed and delivered consistently. Sorting at the feed bunk can cause some animals to consume a very different diet from the formulated ration, so particle distribution, moisture and feed push-up need attention. Feed availability should be maintained through the day, particularly for high-yielding animals, and refusals should be monitored because sudden changes may indicate palatability, mixing or health problems. Protein should be supplied in relation to microbial needs and productive demand rather than simply increased in the hope of obtaining more milk. Excess nutrient supply can increase cost and nutrient excretion without improving production. Where practical, laboratory analysis of forage and concentrate ingredients provides a sound basis for ration formulation because nutrient content may vary with variety, harvest stage, storage and processing. Regular review is required when forage lots change, milk yield shifts or weather alters feed intake.

Minerals and vitamins also influence production, reproduction, skeletal strength and immune function. Calcium, phosphorus, magnesium, sodium and trace minerals should be balanced rather than supplied indiscriminately, because both deficiency and excess can create problems or interfere with the availability of other nutrients. Mineral programmes should consider the composition of forage, concentrates and water as well as commercially supplied supplements. Feed analysis and ration formulation are more reliable than judging nutrient value from appearance alone. Water deserves equal attention because it is required for milk synthesis, digestion and temperature regulation; even a well-formulated ration cannot support high production if animals do not drink enough. Body condition scoring is a practical tool for checking whether energy supply is appropriate over time. A rapid loss of condition after calving may indicate that intake is not keeping pace with demand, while excessive gain in late lactation can increase transition risk in the next cycle. Milk fat and protein trends, rumination, manure consistency and feed refusal can provide additional clues about ration

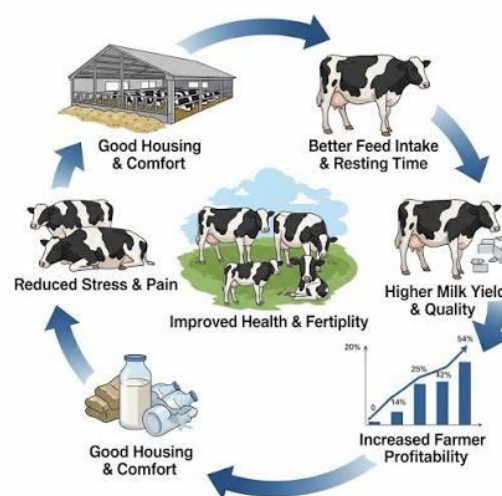
performance. Changes should be interpreted as patterns rather than isolated numbers, since milk components are influenced by breed, stage of lactation, season and health. The most successful feeding programmes are consistent, based on measured ingredient quality and adjusted gradually with input from trained nutrition and veterinary personnel.

Table 1. Stage-wise priorities in scientific dairy management.

Stage	Major priorities
Late pregnancy / dry period	Maintain proper body condition, mineral balance, clean calving area and gradual diet transition.
Fresh period	Monitor appetite, rumination, temperature, udder, uterus and metabolic disease risk.
Early lactation	Maximise safe dry matter intake, control body condition loss and support peak milk.
Mid lactation	Maintain ration consistency, reproduction and udder health; monitor persistency.
Late lactation	Prevent over-conditioning and plan dry-off and next-lactation health.
All stages	Provide clean water, comfort, vaccination, hoof care and accurate records.

Water, Housing and Cow Comfort

Water is the most important nutrient for a lactating dairy animal and must be available in adequate quantity, quality and at convenient locations. Troughs should be clean, easy to reach and capable of supplying water quickly after milking and feeding, when animals often drink heavily. Reduced water availability lowers dry matter intake and milk production, and demand rises sharply in hot weather. Water points should not create narrow passages where dominant animals can block access.



Routine cleaning prevents accumulation of algae, feed material and manure, while periodic

assessment of water quality may be needed where salinity, hardness or microbial contamination is suspected. Housing should support the natural daily time budget of dairy animals. Comfortable cows spend many hours resting, and sufficient lying time is associated with better hoof recovery, rumination and general welfare. Stalls must be appropriately sized and designed so animals can lie down and rise without striking partitions or slipping. Bedding should remain dry and clean, and wet areas around water troughs, alleys and milking facilities should be corrected because prolonged moisture damages hooves and increases hygiene problems. Good housing is not an optional luxury; it is part of the production system because comfort influences feed intake, lameness, udder cleanliness and the animal's willingness to rest.

Comfortable lying areas increase resting and rumination time, while slippery floors, sharp turns and long standing periods increase the risk of lameness and injury. Regular scraping or flushing of alleys helps maintain traction and cleanliness, but surfaces should not become excessively abrasive. Shade, fans and sprinklers can reduce heat load, especially for high-yielding animals whose metabolic heat production is high. Heat stress may first appear as faster breathing, more standing, clustering near water, lower feed intake and reduced milk yield before severe clinical signs develop. Cooling strategies should therefore begin before animals show obvious distress. Feed can be offered more frequently or at cooler times of day to encourage intake, but ration consistency should be maintained. Ventilation is equally important in humid or enclosed buildings because it removes heat, moisture and gases while improving air quality. Stocking density influences almost every aspect of cow comfort; overstocking increases competition for stalls, feed and water and may disproportionately affect timid or recently calved animals. Special-needs groups such as close-up dry cows, fresh cows and lame animals benefit from easy access to feed, water and soft resting areas. Housing should be reviewed from the animal's perspective: whether she can walk confidently, reach resources easily, lie down without obstruction and remain clean. Small structural improvements can yield substantial benefits when they reduce chronic stress or competition.

Milking Management and Udder Health

A consistent milking routine reduces stress and protects teat condition. Udders and teats should be visibly clean, preparation should be consistent and teats dried with individual towels where possible. Operators should follow the same sequence at each milking so milk let-down occurs predictably and teat exposure to contamination is minimised. Milking equipment must operate at appropriate vacuum and pulsation settings and be serviced regularly because poor equipment function can damage teat ends, prolong unit-on time and contribute to incomplete milking. Clusters should be attached and removed carefully, avoiding excessive air admission or overmilking. After milking, cows should have access to fresh feed and a clean standing area for a short period while teat canals begin to close, but prolonged forced standing should be avoided. Parlour hygiene includes regular cleaning of contact surfaces, safe handling of milk and appropriate separation of milk from animals under treatment. Staff training matters because mastitis control depends on many small actions being performed correctly every day. Calm handling also improves let-down and reduces kicking or injury. Milking procedures should be practical enough to be followed consistently even during busy periods, and deviations should be investigated rather than becoming accepted shortcuts.

Mastitis control requires early detection, prevention and accurate treatment decisions. Somatic cell count, clinical examination, milk appearance and, where available, conductivity or culture can support diagnosis. A rising bulk-tank somatic cell count may indicate that subclinical infection is increasing even when clinical cases appear unchanged. Individual cow records help identify recurrent infections and cows that contribute disproportionately to herd cell count. Post-milking teat disinfection, clean bedding, prompt attention to damaged teats and good milking-machine maintenance are key preventive components. Clinical cases should be recorded with date, quarter, severity, treatment and outcome so recurring patterns can be identified. Veterinary-guided therapy is important because not every abnormal udder requires the same drug or duration, and unnecessary antimicrobial use should be

avoided. Milk withdrawal periods must be followed exactly to protect consumers and prevent residues. Dry-period udder management should consider infection history, teat condition, hygiene and the farm's veterinary protocol. Prevention is generally more economical than repeated treatment because mastitis causes discarded milk, reduced yield, labour costs and premature culling in addition to medicine expense. Udder health should therefore be reviewed at herd level rather than only when an individual cow develops swollen quarters or visibly abnormal milk.

Reproductive Efficiency

Long calving intervals reduce lifetime productivity and increase non-productive days, so reproductive efficiency should be monitored as a herd process rather than as isolated breeding events. Heat detection can combine behavioural observation with records or activity monitoring. Standing heat, increased movement, mounting, mucus discharge and changes in social behaviour can help identify oestrus, but expression may be weaker in lame, heat-stressed or high-producing animals. Insemination timing, semen handling and technician skill influence conception, as do uterine health, nutrition and body condition. Animals failing to show heat after calving should be evaluated for energy balance, ovarian activity and postpartum disease instead of being repeatedly inseminated without investigation. A voluntary waiting period should allow uterine recovery, while excessively delayed breeding can prolong days open. Reproductive performance is best interpreted using several measures, including heat-detection efficiency, conception rate, pregnancy rate, services per conception and pregnancy loss. These measures help distinguish whether poor results arise mainly from missed heats, fertilisation failure, health problems or management delays. Reproduction should not be separated from nutrition and comfort because cows experiencing severe body condition loss, lameness, mastitis or heat stress often show poorer fertility.

Pregnancy diagnosis allows early identification of non-pregnant animals and creates an opportunity for timely rebreeding or veterinary examination. Reproductive records

should include calving date, first heat, inseminations, service sire, pregnancy status, pregnancy loss and disorders such as retained placenta or metritis. Body condition at calving and early lactation should be controlled because both excessive loss and over-conditioning reduce fertility. Calving records are also useful for identifying difficult births, stillbirths and patterns related to sire, parity or calf size. After calving, uterine recovery and general health should be observed before breeding decisions are made. Farms using synchronisation programmes need precise compliance with timing, identification and drug protocols; errors in execution can reduce the benefit of the programme. Replacement-heifer management should begin long before first breeding, with growth monitored so animals reach breeding and calving targets without becoming over-fat. Age at first calving affects rearing cost and lifetime productivity, but breeding should be based on adequate development rather than age alone. Ultimately, reproductive management seeks a regular calving pattern that supports milk production without compromising health. Decisions about rebreeding, treatment or culling should combine reproductive history with milk yield, age, disease, welfare and economic considerations.

Table 2. Useful dairy indicators for routine monitoring.

Indicator	What it can reveal
Milk yield trend	Changes in nutrition, health, heat stress or stage of lactation.
Body condition score	Energy balance and risk of metabolic or reproductive problems.
Rumination / cud chewing	Rumen function, fibre adequacy and early illness.
Somatic cell count	Udder inflammation and herd mastitis status.
Days open / services per conception	Reproductive efficiency and possible heat-detection or health problems.
Lameness score	Cow comfort, hoof health and flooring-related risk.

Health, Lameness and Longevity

Disease reduces milk directly and indirectly through lower feed intake, altered metabolism and delayed reproduction. Routine hoof care, comfortable flooring and early treatment of lameness protect welfare and production. Lameness can arise from claw lesions, infectious conditions, injuries or prolonged exposure to wet and hard surfaces, so prevention requires both hoof management and housing improvement. Regular locomotion

scoring helps identify mildly affected animals before they become severely lame. Footbaths, where used, should follow a farm-specific hygiene programme and should not substitute for clean, dry walking surfaces. Vaccination and parasite control should be adapted to regional risks, veterinary advice and farm history rather than applied identically on every farm. Biosecurity is especially important when purchasing or returning animals. New arrivals should be assessed, isolated when appropriate and introduced according to a written herd protocol. Calves and young stock require their own preventive programme, because disease in early life can influence later growth and productivity. Clean colostrum management, hygienic feeding equipment, ventilation and prompt treatment of diarrhoea or respiratory disease are fundamental. Adult-herd performance depends partly on how well replacement animals are raised, so young-stock health should be included in the same record and review system as lactating-cow health.

Longevity is an important economic and welfare trait. An animal that remains healthy and productive for more lactations spreads rearing costs over a longer period and reduces the number of replacements required. Culling decisions should therefore consider chronic disease, fertility, udder health, lameness, production and welfare rather than milk yield alone. Repeated involuntary culling for mastitis, infertility or locomotion problems is often a sign that herd-level risk factors deserve investigation. A sound longevity strategy begins with good calf and heifer development, continues through careful transition management and depends on preventing chronic problems throughout lactation. Hoof trimming schedules, comfortable resting surfaces, mastitis prevention and reproductive monitoring all contribute. The objective is not to keep every animal indefinitely, but to avoid preventable loss of otherwise productive animals. Deaths and emergency culls should be reviewed because they may reveal late disease detection, calving problems, nutritional errors or facility hazards. Where possible, post-mortem findings can add useful information. Welfare assessment should be part of longevity decisions; animals with persistent pain or poor prognosis should not be retained simply to delay replacement cost. Healthy longevity

reflects the cumulative quality of daily management and is therefore a valuable summary measure of how well the whole dairy system is functioning.

Record-Based Dairy Management

Daily or monthly milk records allow comparison among animals and groups. When combined with feed use, body condition, disease and reproductive data, they can identify whether a decline is associated with nutrition, health, environment or stage of lactation. Records also help evaluate the response to ration changes, cooling systems, mastitis-control measures or reproductive interventions. The value of a record depends on accuracy and regular review; large amounts of data that are never examined do not improve management. Farms can begin with a small set of indicators that directly support decisions, then add detail as staff become comfortable with the system. Useful records include calving, milk yield, milk components, treatments, withdrawal dates, mastitis, lameness, inseminations, pregnancy results, body condition, culling and mortality. Feed delivery and refusals can be linked with group milk output to assess feed efficiency. Digital herd-management software can simplify trend analysis and generate alerts, while wearable sensors may provide continuous information on activity, rumination or other behaviours. However, alerts should lead to animal observation and clinical evaluation rather than automatic treatment. Data quality improves when animal identification is reliable and workers understand why each entry is important.

Useful indicators include peak milk, lactation persistency, days open, services per conception, pregnancy rate, clinical mastitis rate, somatic cell count, lameness prevalence and culling reasons. Each measure should be interpreted in context. For example, lower milk in a group may reflect normal late-lactation status rather than a feeding failure, while poor conception may coincide with heat stress or postpartum disease. Regular review converts farm records into management decisions and helps ensure higher production is achieved efficiently. Monthly or quarterly herd meetings can compare current performance with previous periods and agreed targets. When a problem is identified, the next step should be a specific

action and a date for reassessment. If lameness rises, flooring, hoof-trimming records and stall comfort may be reviewed; if mastitis increases, bedding, milking procedure and infection patterns can be examined. Financial information can also be linked with biological records to estimate the cost of disease, feed wastage or extended days open. Benchmarking against similar farms may provide perspective, but internal trends are often more useful because management systems differ. Record-based management works best when data remain simple enough to be accurate, are reviewed consistently and are translated into practical changes that workers can understand and implement.

Conclusion

Scientific dairy management combines nutrition, comfort, reproduction, udder health, disease prevention and record keeping. The greatest improvements usually come from correcting several small weaknesses rather than relying on one expensive technology. Transition-cow care, adequate water, balanced rations and consistent milking provide a strong foundation, but their benefits depend on everyday execution. Animals should have sufficient time and space to eat, drink and rest, while workers need clear protocols for detecting abnormal behaviour, fever, appetite loss, mastitis, lameness and reproductive problems. Preventive health programmes should be designed with veterinary input and reviewed as herd size, housing, feed resources or local disease risks change. Technology can support this work by providing alerts and trends, but it cannot replace good observation, skilled stockmanship or accurate diagnosis. The central principle is consistency: cows respond best when feeding, milking and handling occur predictably and when abrupt nutritional or social changes are minimised.

Sustainable high yield should be measured together with fertility, disease incidence, feed efficiency, welfare and longevity. When decisions are based on animal needs and reliable records, dairy animals are better able to express their genetic potential while maintaining health. A farm that routinely reviews body condition, milk trends, udder health, reproduction, lameness and transition outcomes can identify preventable losses and

prioritise the most useful interventions. Higher milk production should therefore be viewed as the result of a well-functioning system rather than the product of a single feed additive, machine or treatment. Scientific management is ultimately a process of continuous improvement: observe, record, interpret, act and then evaluate the response. When this cycle is applied consistently, farmers can improve productivity while using feed, labour and medicines more responsibly. The long-term goal is a dairy enterprise in which profitability is supported by healthy animals, skilled workers, good welfare and management decisions that remain practical under local conditions.

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