TASSELLS Farm Limited
Re-Defining Agri-Living

A Comprehensive Guide to Dairy Cattle Breeding and Herd Improvement.

THE SCIENCE OF SUSTAINABLE EXCELLENCE

Authored by Tassells Farm Limited (TFL) Research Division

Dairy agri-research.

BREEDING HYBRID DAIRY ANIMALS

it was the elderly farmer who said "*I saw the ancestral setup of these animals, from weak unproductive sickly cows to what you are looking at now, champions of productivity***"**

AND so

Muturi & Susan Njoroge

Introduces

Through the eyes of dairy cattle generations

Science of Sustainable Excellence and Comprehensive Guide to Dairy Cattle Breeding

Genetics & Herd Improvement Division

This article provides dairy farmers, livestock practitioners, and researchers with a scientifically backed guide for dairying process of high-yielding hybrid dairy cows. It reflects the innovations and lessons by Tassells Farm Limited, an award-winning agribusiness redefining dairy farming.

Preface

For generations, dairy farming has been the cornerstone of agriculture, providing essential nutrition to the world. Tassells Farm Limited, believe that the future of this noble industry lies not in chance, but in choice. The choice to embrace science, to prioritize animal well-being, and to commit to a vision of sustainable, profitable, and ethical milk production.

This booklet is a testament to that belief. It is designed to be an indispensable resource for our affiliate farmers, herd managers, veterinary professionals, and anyone with a vested interest in the genetic advancement of dairy herds. The path to a superior herd is complex, weaving together the threads of genetics, **nutrition, management, and animal health**. A weakness in any single thread can unravel the entire tapestry of potential.

Within these pages, we move beyond **simplistic advice** and delve into the **profound depth** of modern dairy breeding. We explain not just the "how," but the crucial "why." We address the significant risks of poor breeding practices, including the devastating consequences of **inbreeding depression** and the **propagation of genetic disorders**. Most importantly, we outline **a holistic breeding philosophy** that targets not just milk volume, but the creation of a **resilient, efficient, and profitable** animal that thrives in its environment.

This is a call to action for informed breeding. We invite you to study this guide, to question, and to implement these principles. Together, we can build a legacy of excellence for Tassells Farm Limited and our entire network.

– Susan N. Njoroge MD. Tassells Farm Limited

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Chapter 1: The Philosophy of Breeding – Why We Breed

Breeding is the most powerful long-term management tool available to a dairy farmer. It is the process of making deliberate, informed decisions to change the genetic makeup of the next generation. While daily management addresses the *expression* of an animal's potential (through nutrition, comfort, and healthcare), breeding defines the *ceiling* of that potential.

The primary goals of a serious breeding program at Tassells Farm Limited are:

1. **To Improve Herd Profitability:** This is the fundamental economic driver. Profitability is not just increased milk sales. It is a function of:
   - **Increased Revenue:** Higher milk, fat, and protein yield.
   - **Reduced Costs:** Lower veterinary bills (improved health), reduced feed input per unit of output (improved efficiency), and decreased replacement heifer costs (improved longevity).
2. **To Enhance Animal Welfare and Functionality:** A genetically superior cow is one that is fit for its purpose and environment. She must be healthy, fertile, able to calve unassisted, resistant to diseases like mastitis, and able to walk comfortably on her feet and legs. Breeding for functionality is an ethical imperative and an economic one.
3. **To Achieve Sustainability and Resilience:** The modern dairy cow must be efficient, converting feed into milk with minimal waste. She must be robust, with a strong immune system to reduce antibiotic use. She must have a long productive life, reducing the environmental footprint associated with raising replacement animals. This resilience makes the entire farming operation more sustainable and buffer against market or climatic fluctuations.
4. **To Produce a Product that Meets Market Demands:** Breeding must be aligned with the market. This may mean targeting specific milk components (e.g., high protein for cheese yield, specific fat profiles for liquid milk), or ensuring cattle are

of a type suitable for specific production systems (e.g., grazing-based vs. confinement).

In essence, we breed to change the future. Every mating decision is an investment in the herd's genetic trajectory for the next three to five years. There is no room for short-term thinking or aesthetic whims.

Chapter 2: The Genetic Blueprint – Understanding the Tools

2.1. Quantitative Genetics & Estimated Breeding Values (EBVs)

The traits we care about in dairy cattle (milk yield, fertility, etc.) are **quantitative traits**. They are controlled by many genes (polygenes), each with a small effect, and are significantly influenced by the environment. We cannot select for them based on appearance alone.

The solution is the **Estimated Breeding Value (EBV)**. An EBV is a statistical estimate of an animal's genetic merit for a trait, independent of its environmental advantages (e.g., better feed). It is calculated by comparing the animal's performance records to the performance of all its relatives (parents, progeny, siblings). For example, a bull with an EBV of +500 kg for milk is predicted to sire daughters that will produce 500 kg more milk per lactation than daughters of a bull with an EBV of 0.

2.2. Genomic Selection: A Revolution in Accuracy

This is the cornerstone of modern breeding. Instead of waiting for a bull to have hundreds of daughters whose milk we can measure (a process taking 5-7 years), we can now take a DNA sample from a newborn calf.

- The DNA is genotyped on a chip that reads hundreds of thousands of genetic markers (Single Nucleotide Polymorphisms - SNPs) across the genome.

- By comparing this genotype to a vast reference population of animals with known EBVs and genotypes, a **Genomic EBV (GEBV)** can be calculated with high accuracy immediately.
- This has slashed generation intervals, dramatically accelerated genetic gain, and improved the accuracy of selection for low-heritability traits like fertility.

2.3. Key Performance Indicators (KPIs) and Their Economic Weighting

No single trait exists in isolation. Therefore, breeding programs use **Selection Indices**. These are weighted formulas that combine EBVs for multiple traits into a single, overall economic value ($). This allows for balanced selection.

Example of a Tassells Profit Index ($TPI):
$TPI = (0.3 * Milk $) + (0.25 * Fertility $) + (0.2 * Health $) + (0.15 * Longevity $) + (0.1 * Conformation $)

This index places a 30% emphasis on production traits, but a combined 70% emphasis on health, fertility, and longevity—ensuring the animals we create are profitable and sustainable.

Chapter 3: The Ideal Phenotype – What We Look For (The Breeding Goal)

Our breeding goal is a cow that is **efficient, robust, and profitable**. Below is the breakdown of the trait categories we must prioritize.

3.1. Production Traits

- **Milk Yield (kg/lactation):** The base volume.
- **Fat Yield (kg) & Protein Yield (kg):** Often more valuable than volume alone. Component pricing is standard.
- **Fat % & Protein %:** Indicators of milk quality and cheese yield.

3.2. Functional Traits (The Foundation of Longevity)

- **Somatic Cell Count (SCC) EBV:** A low EBV indicates genetic resistance to mastitis. This is one of the most critical health traits.
- **Daughter Fertility EBV:** Measures the genetic ability of a bull's daughters to get back in calf quickly. Expressed as a reduction in calving interval.
- **Calving Ease (Direct & Maternal): Direct** refers to a sire's ability to produce calves that are born easily. **Maternal** refers to a dam's genetic ability to calve easily. We prioritize sires with high Calving Ease Direct EBVs, especially for heifers.
- **Livability/Longevity EBV:** The genetic propensity for a long, productive life. A cow that lasts 5 lactations is vastly more profitable than one that lasts 2.

3.3. Conformation Traits (Form Follows Function)

- **Udder Composite:** Deeply attached, strong central ligament, well-placed teats. This supports high production and reduces mastitis and injury risk.
- **Foot & Leg Composite:** Correct leg angle, deep heel, strong pasterns. Essential for mobility and longevity on hard surfaces.
- **Body Depth & Chest Width:** Indicates capacity for feed intake, a key driver of production. A "deep chest" signifies heart and lung capacity.
- **Dairy Character:** A blend of angularity and openness that indicates efficient conversion of feed to milk, not body fat.

3.4. Health & Immunity Traits

- **Genetic Disease Resistance:** Specific EBVs are now available for resistance to diseases like **Johne's, Bovine Respiratory Disease (BRD), and Mastitis**.
- **Metabolic Disease Resistance:** EBVs for reduced susceptibility to **Ketosis** and **Milk Fever**.
- **Immune Response:** General genetic ability to mount an effective immune response to challenges.

3.5. The All-Important Feed Efficiency Trait

This is the next frontier. **Residual Feed Intake (RFI)** measures the difference between an animal's actual feed intake and its expected intake based on its size and production. A negative RFI EBV is desirable—it means the cow produces the same amount of milk while eating *less* feed than predicted. This is a direct cost saver.

Chapter 4: The Perils of Poor Practice – What We Avoid

4.1. Inbreeding Depression: The Silent Herd Killer

Inbreeding is the mating of related individuals. It increases **homozygosity**, meaning both copies of a gene are identical. This has severe consequences:

- **Reduced Fertility:** Higher rates of embryonic loss and stillbirths.
- **Lower Production:** Significant decline in milk, fat, and protein yield.
- **Poor Health:** Weakened immune systems and higher incidence of genetic disorders.
- **Reduced Vitality:** Lower birth weights, poorer growth rates, and shorter lifespans. Every 1% increase in inbreeding coefficient reduces milk production by approximately 25-30 kg per lactation. Managing inbreeding is non-negotiable. We must track the **Inbreeding Coefficient (F%)** for every mating.

4.2. A Catalog of Common Genetic Disorders

Mating two carriers of a recessive disorder has a 25% chance of producing an affected calf. We must use genetic testing to avoid carrier-to-carrier matings.

- **Brachyspina (BY):** Lethal. Causes shortened spine, malformed organs, and abortion.
- **Complex Vertebral Malformation (CVM):** Lethal. Causes abortion, stillbirth, and deformed calves.

- **Deficiency of Uridine Monophosphate Synthase (DUMPS):** Lethal. Causes early embryonic death.
- **Bovine Leukocyte Adhesion Deficiency (BLAD):** Lethal. Causes recurring infections, slow growth, and death in young stock.
- **Citrullinemia (CI):** Lethal. Neurological disease causing death shortly after birth.
- **Factor XI Deficiency (FXI):** Bleeding disorder that can complicate dehorning or calving.
- **Crooked Tail Syndrome (CTS):** Non-lethal but undesirable.

4.3. The Economic and Ethical Cost of Neglecting Functional Traits

Focusing solely on milk yield while ignoring fertility, health, and feet/legs leads to:

- **A herd of "culls":** Animals that are high-producing but break down and leave the herd early due to lameness, infertility, or mastitis.
- **Skyrocketing veterinary and drug costs.**
- **Poor animal welfare,** leading to public scrutiny.
- **Ultimately, lower profitability** despite high milk volumes.

Chapter 5: Methods of Breeding – From Art to Science

5.1. Straightbreeding: Linebreeding and Inbreeding

- **Inbreeding:** As discussed, is generally avoided due to its depressive effects. It is only used by highly skilled geneticists to fix an extremely desirable trait in a closed population, with severe risks.
- **Linebreeding:** A mild form of inbreeding that aims to concentrate the genetics of a particular outstanding ancestor while minimizing the overall increase in inbreeding coefficient. It requires meticulous planning.

5.2. Outcrossing

Mating genetically unrelated individuals within the same breed. This is the standard practice for most commercial matings to maintain genetic diversity and avoid inbreeding depression.

5.3. Crossbreeding: The Power of Hybrid Vigor (Heterosis)

Mating animals from two different breeds. The offspring (F1 cross) often exhibit **heterosis**: performance that is superior to the average of both parents.

- **Advantages:** Dramatic improvements in fertility, survival, health, and longevity. It is a powerful tool to rapidly improve functional traits.
- **Disadvantages:** Less consistent type and milk components. Can complicate a purebred marketing strategy.
- **Common Crosses:** Holstein x Jersey (for high components and fertility), Holstein x Scandinavian Red (for health and fertility).

5.4. The Modern Paradigm: Genomically-Assisted Selection

The standard practice for Tassells affiliates:

1. **Genotype** all heifer calves.
2. **Rank** them based on your custom selection index (e.g., $TPI).
3. **Select** the top 70-80% as herd replacements.
4. **Mate** each selected female to a genomically-high-ranked sire that:
   - Compliments her strengths and weaknesses.
   - Has the specific trait genetic profile you need (e.g., high Fertility EBV, low SCC EBV).
   - **Is a low-inbreeding match for that specific cow** (using mate matching software).
5. Use **Sexed Semen** on the top 50% of the herd to accelerate genetic progress, and **Beef Semen** on the bottom tier to generate a valuable beef cross calf.

Chapter 6: The Execution – From Detection to Conception

6.1. Mastering Heat Detection: Methods and Signs

A missed heat costs 21 days of milk. Key signs:

- **Primary Sign:** Standing to be mounted by a herdmate. This is the only reliable confirmation of estrus.
- **Secondary Signs:** Mucus discharge, swollen vulva, restlessness, increased activity (measured by pedometers or neck tags), chin resting, dirt on the flanks, and ruffled tailhead.

6.2. The Optimal Timing of Insemination

Ovulation occurs approximately 28-32 hours *after* the onset of standing heat.

- The egg is viable for about 8-12 hours.
- Sperm need 6-8 hours to undergo **capacitation** (become capable of fertilizing) and remain viable in the reproductive tract for ~24 hours.
- **The "AM-PM Rule":** If you see standing heat in the **morning**, inseminate in the **evening**. If you see standing heat in the **evening**, inseminate the **next morning**. This aligns the fertile lifespan of both sperm and egg.

6.3. The Science of Sexed Semen

This technology sorts X-chromosome (female) sperm from Y-chromosome (male) sperm based on a slight difference in DNA content.

- **Accuracy:** ~90% female calves.
- **Conception Rates:** Are typically 70-80% of conventional semen. This must be factored into the timing and management.
- **Strategy:** Used on genetically superior, problem-free cows and heifers to rapidly improve the herd's genetic base.

Chapter 7: When Conception Fails – Analyzing Breeding Inefficiency

A conception rate below 40% requires immediate investigation.

7.1. Nutritional Deficiencies and Imbalances

- **Energy Balance:** Negative energy balance post-calving is the single biggest cause of poor fertility. The cow cannot support pregnancy.
- **Minerals & Vitamins:** Deficiencies in **Phosphorus, Copper, Selenium, Vitamin E, Vitamin A**, and **Iodine** directly impact cyclicity and embryonic survival.

7.2. Management and Environmental Stressors

- **Heat Stress:** High temperatures reduce semen quality, embryo quality, and increase early embryonic death.
- **Overcrowding, Poor Footing, and Lameness:** Cause stress and reduce expression of estrus.
- **Inaccurate Heat Detection:** The most common management failure.

7.3. Infectious Diseases and Reproductive Health

- **Metritis, Endometritis,** and **Pyometra:** Uterine infections prevent embryo implantation.
- **BVDV (Bovine Viral Diarrhea Virus):** Causes early embryonic death, abortion, and birth defects.
- **Leptospirosis** and **IBR (Infectious Bovine Rhinotracheitis):** Can cause abortion storms.

7.4. Anatomical and Genetic Infertility

- **Freemartin Heifers:** A female twin born with a male twin is almost always infertile due to shared blood in utero.
- **Ovarian Cysts:** Disrupt the normal estrous cycle.

- **Uterine or Oviduct Blockages:** Often a result of prior infection.

Executive Conclusion: The Path to a Profitable and Sustainable Herd

The science of dairy cattle breeding has evolved from an art form into a precise, data-driven discipline. The potential for genetic improvement has never been greater, but so too has the consequence of poor decisions. The path forward for Tassells Farm Limited and our affiliates is clear:

1. **Define a Clear Breeding Goal:** Move beyond milk volume. Develop a custom selection index that heavily weights **fertility, health, longevity, and feed efficiency**. This creates a resilient, low-input, high-output cow.
2. **Embrace Technology: Genotype your replacement heifers.** This is no longer optional for a serious operation. It is the most powerful tool for accurate selection and avoiding inbreeding.
3. **Prioritize Management:** The best genetics are wasted on poor management. Excellence in **nutrition, cow comfort, and reproductive health** is required to unlock genetic potential.
4. **Avoid Genetic Risks: Rigorously track inbreeding** and avoid carrier-to-carrier matings for genetic disorders. These practices protect your herd from devastating recessive traits and the insidious profit drain of inbreeding depression.
5. **Execute with Precision:** Master heat detection and optimal insemination timing. Use **sexed semen** strategically on your best animals and **beef semen** on the rest to add value and accelerate progress.

This booklet provides the blueprint. The responsibility now lies with us to implement it. By committing to this science-based, holistic approach to breeding, we will not only ensure the profitability of our individual operations but also secure the long-term sustainability and social license of the entire Tassells Farm network. We are building the

next generation of dairy cattle—let us build it with wisdom, foresight, and scientific excellence.

Glossary of Terms

- **EBV (Estimated Breeding Value):** A prediction of an animal's genetic merit for a trait.
- **GEBV (Genomic EBV):** An EBV calculated using DNA marker information.
- **Heritability (h^2):** The proportion of differences in a trait that are due to genetics and can be passed on. Ranges from 0 (low) to 1 (high).
- **Heterosis (Hybrid Vigor):** The superior performance of a crossbred animal compared to the average of its purebred parents.
- **Inbreeding Coefficient (F%):** The probability that two genes at any locus are identical by descent. Measures how related an animal's parents are.
- **Inbreeding Depression:** The reduction in performance and fitness resulting from inbreeding.
- **Index (e.g., $TPI):** A single value that combines EBVs for several traits into one overall score based on their economic importance.
- **KPI (Key Performance Indicator):** A measurable value that demonstrates how effectively a farm is achieving key business objectives (e.g., Calving Interval, Somatic Cell Count).
- **Lactation:** The period between one calving and the next, typically ~305 days of milk production.
- **Phenotype:** The observable physical or biochemical characteristics of an animal, determined by both its genotype and the environment.
- **Genotype:** The genetic makeup of an individual.
- **Recessive Disorder:** A genetic disorder that is only expressed if an individual inherits two copies of the mutant allele, one from each parent.
- **Sexed Semen:** Semen that has been processed to enrich the population for X-chromosome bearing sperm (for female calves).

- **Somatic Cell Count (SCC):** The number of white blood cells per milliliter of milk. A key indicator of udder health and milk quality.

Appendices

Appendix A: Genetic Disorder Inheritance Patterns and DNA Tests

Disorder	Acronym	Inheritance	Effect	Available Test
Brachyspina	BY	Recessive	Lethal	Yes
CVM	CVM	Recessive	Lethal	Yes
DUMPS	DUMPS	Recessive	Lethal	Yes
BLAD	BLAD	Recessive	Lethal	Yes
Citrullinemia	CI	Recessive	Lethal	Yes
Factor XI Deficiency	FXI	Recessive	Bleeding	Yes
Crooked Tail Syndrome	CTS	Recessive	Non-Lethal	Yes

Appendix B: Body Condition Score (BCS) Chart (1-5 Scale)

- **BCS 1 (Emaciated):** Sharp bones, no fat cover.
- **BCS 2 (Thin):** Bones easily visible, little fat.
- **BCS 3 (Ideal):** Bones smooth, covered by fat. Ribs palpable but not visible.
- **BCS 4 (Fat):** Ribs difficult to palpate. Fat deposits visible.
- **BCS 5 (Obese):** Bone structure not discernible. Heavy fat deposits.

(A visual chart with images of cows at each score would be included here in the printed booklet.)

Appendix C: Heat Detection Checklist and Record Sheet

(A table for recording cow ID, dates, observed signs, and action taken would be included here.)

Appendix D: Calculation of Inbreeding Coefficient (Fx)

Fx is calculated using complex pedigree analysis software. The formula is based on Wright's Algorithm:

$$Fx = \Sigma [(1/2)^{(n+1)} * (1 + FA)]$$

Where the sum is over all paths through common ancestors, n is the number of individuals in a path connecting the sire and dam through the common ancestor, and FA is the inbreeding coefficient of the common ancestor.

In practice, farmers use mating software that automatically calculates F% when sire and dam pedigrees are entered.

References and Further Reading

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Tassells Farm Limited – Committed to Genetic Progress Through Science.

Building a Legacy of Excellence.

The future of the dairy industry lies not in chance, but in choice. This guide is a testament to the belief in embracing science, prioritizing animal well-being, and committing to a vision of sustainable and profitable milk production.

Moving beyond simplistic advice, these pages delve into the profound depth of modern dairy breeding, explaining not just the "how," but the crucial "why". It provides a blueprint for creating a resilient, low-input, high-output cow by defining a clear breeding goal that heavily weights fertility, health, longevity, and feed efficiency.

This is an indispensable resource for farmers, herd managers, and veterinary professionals dedicated to the genetic advancement of dairy herds.

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