9

Genetics

This chapter discusses the role of genetics on small holder farm performance and profits.

The main points in this chapter

- The continued emphasis on temperate dairy genotypes, which are essentially exotic to tropical small holder farms, has had little impact on cow performance or farm profitability over the last few decades.
- The concept of genotype by environment interaction is introduced to explain the need to modify the farm environment to get the most benefit out of improved dairy genotypes.
- Several tropical dairy breeds have been developed, such as the Australian Milking Zebu and the Australian Friesian Sahiwal.
- The availability of artificial insemination has the greatest effect on the farmer's ability to initiate a breeding program.
- In Sri Lanka, despite the extensive use of AI, over 65% of the progeny are born from local bulls. This is attributed to the poor infrastructure of AI services as well as the lack of farmer confidence that AI will result in a pregnancy.

Improved genetics is just one of the tools for increasing farm production, but it is only effective if used in combination with other better farm management practices. This is described by animal geneticists as follows:

$$\text{Phenotype} = \text{genotype} + \text{environment}$$

The performance of milking cows (phenotype) then results from a combination of:

- genetic makeup (genotype), derived from the genes supplied by both dam and sire
- management in the milking herd (environment) – how well they are housed, fed and protected from climatic stress, disease and other stresses of dairy farming.

Domestic beef and dairy cattle are essentially of two types: tropical Zebu *(Bos indicus*) and temperate (*Bos taurus*). The temperate breeds have been intensively selected

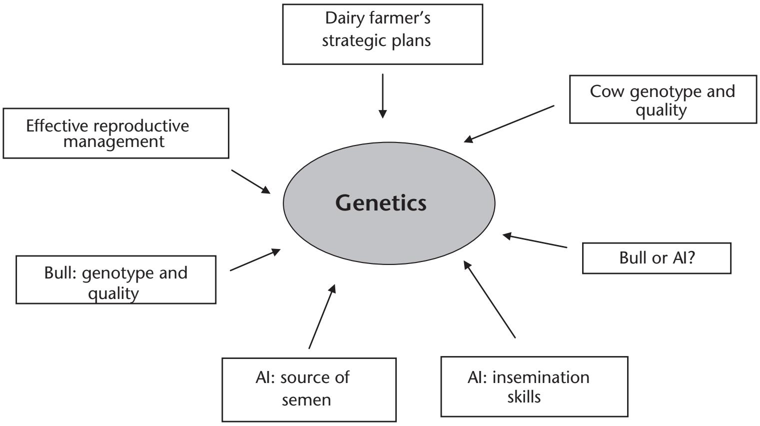


Figure 9.1. The key factors affecting genetic development of the milking herd

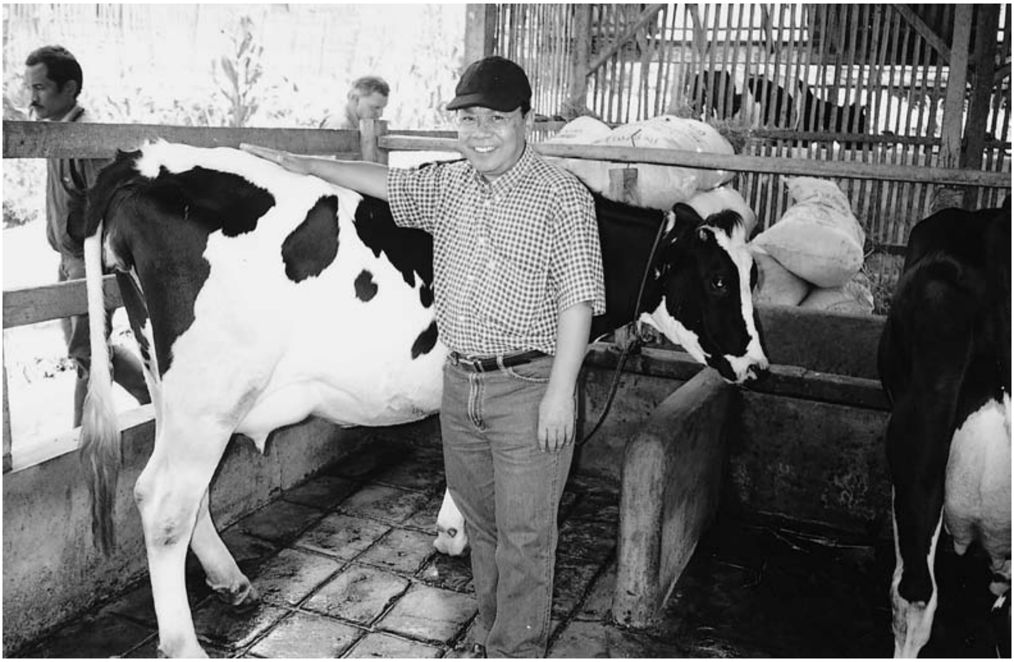
for meat and milk production for several centuries, whereas such breeding programs have only very recently been applied to the tropical breeds.

The relative importance of the genotype and environment differs between climatic zones, farming systems and farmer skills, and it is not easy to apportion relative values to either one. This is a major dilemma for dairy industry policymakers in deciding whether the long-term outcome of schemes to import high genetic merit dairy stock has been genetic improvement, herd multiplication or a combination of the two. Unfortunately, in too many cases, the genetic benefits of such importation schemes have been minimal. Much of the following information is over 20 years old, but many tropical dairy specialists would consider that little has changed and the same types of mistakes are being continually repeated.

9.1 Problems with exotic genotypes

The decision makers of most, if not all, Asian countries place high credence on improving the genetic quality of their national herds. This has led to an influx of *Bos taurus* dairy stock from temperate areas, where they have been selected for many generations. According to McDowell (1994), over 25 countries in the 'low latitudes' (namely equatorial and tropical areas) are developing local milk industries based on imported dairy cattle, mainly Friesians from the temperate developed dairy industries in Europe, North America and Australasia. During the 20 years to 1995, five million Friesians have been exchanged in international trade, of which half have moved from temperate climate countries to those in the warm climate zones. All countries in Latin America have nucleus herds based on Friesians, as do 70% of Asian and 66% of African countries. The major exception has been India, which has based its genetic improvement program on indigenous dairy cattle and buffalo.

The importing countries are also being encouraged, often through financial subsidies, to use semen from progeny tested sires from countries of origin of these cattle, thus continuing the program of genetic upgrading of the temperate dairy stock. But with



A proud farmer with his imported dairy heifer (Indonesia).

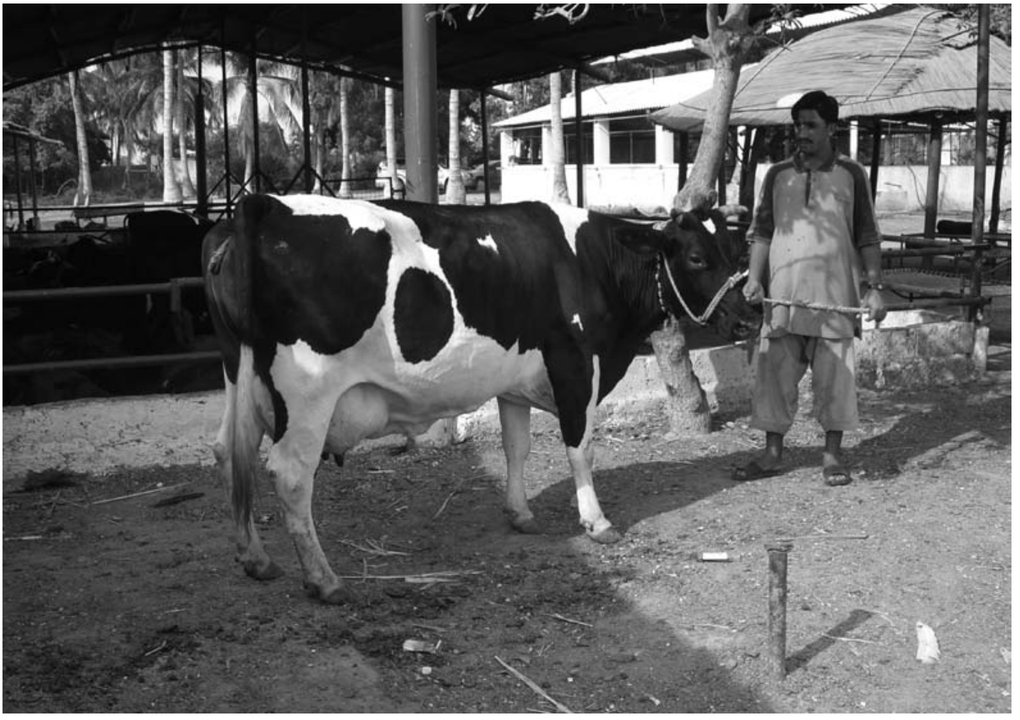
few exceptions, ages at first calving of 30+ months, milk yields of 2500–5000 kg/lactation and calving intervals of 430–485 days in the new location are below optimum and will not even support bank rates of credit (McDowell 1994). Modern day Friesians are genetically capable of producing their first calf at 2 yr of age, then one every 12 months, yielding 8000 kg milk over 300 days and milking for five lactations.

Ibrahim *et al.* (1992) reviewed 10 yr of dairy development in Indonesia (East Java), concluding that increases had been mainly through imported cattle, but productivity gains were only at one-third of their genetic potential. The main reasons they listed would be relevant to many SE Asian countries, being:

- lack of sufficient high-quality feed
- poor adaptability of imported stock to local conditions
- poor housing and management
- too much attention of cooperatives to marketing and insufficient extension on cow problems
- failure to repay dairy credit in view of low productivity and poor milk prices.

9.1.1 Jerseys versus Friesians in the tropics

Apart from small numbers of Brown Swiss and Red Danes, Jerseys and Friesians have been the exotic breeds of choice for genetic upgrading in the tropics. On the whole, Jerseys and their crossbreds have lower full lactation yields of milk or milk solids than Friesians and their crossbreds (Tibbo *et al.* 1994). The Jerseys' earlier age at first calving



A quality Friesian heifer selectively bred in Pakistan.

reflects their faster rate of maturity. Friesians have longer calving intervals, presumably because of their longer period of negative energy balance post-calving. For other production measures, such as services per conception, conception rates, abortion rate and level of mastitis infection, breed differences are small. Increasing numbers of dairy development programs in SE Asia are looking towards purebred and crossbred Jerseys to form the basis of their exotic breed imports. Being smaller and in less demand in developed countries, Jerseys can generally be sourced more cheaply and have lower transportation (air) costs than Friesians.

9.1.2 Genotype by environment interactions

Like all genetic improvement programs, be they livestock, cereal grains or fruit trees, the use of exotic gene stock needs to be accompanied with modifications to the environment. McDowell (1994) contends that this is not happening with dairy cattle because there is still the perception that Friesians, Jerseys or other improved dairy breeds can perform well on diets based on low to moderate digestible tropical grasses in a foreign environment with temperature, disease, pollution and other production constraints.

Small holder dairying uses a wide range of dairy stock in the humid tropics. These include the following types:

1. local, unimproved cattle with little breeding for milk production
2. crosses between local cattle and Zebu dairy breeds

3. crosses between local cattle and temperate dairy breeds
4. purebred temperate dairy breeds.

There is continuing discussion over the 'ideal' genotype for small holder dairying in the humid tropics. One rational approach is to consider the genotype by environment interaction (that is G × E). Briefly, the relative performance of two genotypes depends on environment under which they are managed. When upgrading a national dairy industry from type 1 above, is it better to base the industry on types 2 or 3 and eventually on type 4? More importantly, at what level of feeding and general herd management should the industry move from type 3 to type 4 cows?

The evolution of the dairy industry in the wet tropics of Central America is a good example of understanding how the breed must fit the system. There, the industry is now based on dual purpose cattle rather than, as it was 20 yr ago, on traditional specialist dairy breeds such as Friesians. Cows are milked with the calf at foot and weaning generally coincides with the end of lactation. Income is generated from milk plus quality meat from yearling stock, rather than just the poor-quality meat from cull cows as is usual in most dairy systems. This system has evolved because the dairy cows, being Zebu type, require the presence of a calf to stimulate milk let-down, and they tend to dry off prematurely when daily calf contact ceases, and because milk substitutes and high-quality calf concentrates are either not available or prohibitively expensive.

No single tropical dairy type can be defined as the 'best'. The 'best' type will vary from local genotypes through to high grade Friesians. Unless heat stress is controlled, very high-yielding temperate breeds will always be less efficient than locally evolved ones. Such animals would be developed through crossbreeding local and exotic breeds then selecting within these populations for high milk yields. Similarly, it is unlikely that purebred local breeds will be the most profitable in all but the poorest of situations, where feed is inadequate, parasites and diseases are uncontrolled and levels of production barely fulfil household needs.

The genotype and its management must then be matched to the:

- climatic conditions that exist
- available nutrition, whether home grown or supplemented with purchased feeds
- degree of challenge from parasites and diseases
- level of management skills
- availability and costs of labour to feed, milk and market the product, and its priority with other household demands
- availability of finance
- availability and access to profitable markets.

9.2 Specially bred tropical dairy genotypes

The ideal tropical dairy genotype is a small animal that yields high levels of milk and/or milk solids, produces a live calf (preferably a heifer calf) annually under simple small holder production systems based on tropical forages and with minimal environmental manipulation and low exposure to disease. Unfortunately, such a genotype does not exist because high milk yields require high intakes of quality forages together with high internal heat production, hence management to alleviate heat stress.

Over the last 50 yr, there have been various programs to develop tropically adapted dairy genotypes. These include the Jamaica Hope (80% Jersey, 15% Sahiwal and 5% Friesian) in the Caribbean and the Australian Milking Zebu (AMZ) and Australian Friesian Sahiwal (AFS) in Australia. The objective of such breeding programs was to breed a stabilised genotype with the combined attributes of tropical adaptation and superior milk and reproductive performance. Although such stock would not exhibit the hybrid vigour of crossbreeds, their progeny would be less variable in their physical and productive traits.

The AMZ program, which ceased in the 1970s, was based on Jersey and Red Sindhi breeds, and produced a relatively small cow with low yields of high solids milk. Such a genotype would be ideal for many small holder industries, such as in Indonesia, where most of the milk is destined for industrial processing (hence the benefits of high solids content) and the feeding management is better suited to small cows with low maintenance requirements. However, when recently asked about the suitability of such a genotype, industry leaders in Indonesia considered it less suitable to Jersey or AMZ because of the Friesian's better dairy beef sale value for bull calves or cull cows.

The more successful AFS program, which ceased in the 1990s, was based on Friesian and Sahiwal breeds. Such animals are currently in great demand throughout Asia because of their performance in small holder dairy systems. Their Sahiwal ancestry provided the desired tropical adaptation to complement the dairy performance of the Friesian. Preliminary discussions are now underway to resurrect this breeding program. Such a program would require a good database on the genetic variability of local Friesian populations: a shortfall in many Asian countries where robust herd recording, and performance and progeny testing programs are often lacking.

Another dairy breeding program creating interest in the tropics has produced the Brazilian Girolanda breed. These cattle are now the major dairy breed in Brazil and were bred by crossing the local Gir (*Bos indicus*) cattle with the Friesian. Although popular since the 1940s, the breed was officially established (containing 5/8 Friesian and 3/8 Gir) only in the late 1980s. Some of its attributes include:

- It is reputed to exhibit a degree of hybrid vigour as a result of its two vastly different parent breeds.
- It has good tropical adaptation, thus has good milk production in all tropical climates.
- It has a quiet temperament.
- It exhibits ease of calving.
- It has high fertility, particularly good conception rates during the hotter months.
- It has longevity in the milking herd.
- It has good resistance to parasites.

Another *Bos indicus* breed that has been selected for dairy production is the Sahiwal. This is an indigenous dairy bred from Pakistan and, when managed well, can be a good milk producer. The Sindhi is another potentially good Zebu dairy breed from the Indian subcontinent.

9.3 Breeding decisions to be made on the farm

Each dairy farmer should have a strategic plan for his breeding management. For SHD farmers, plans are likely to be very similar, with the major decision being the particular breed of milking cow the farmer desires and that the cow only requires a minimal number of services or artificial inseminations. Some farmers may like a particular bull type, whose progeny are more likely to have some specific body conformation or certain milk compositional characteristics, but small holder farmers rarely get to have much choice in the semen they can source.

Accessibility to AI is a major determinant of planning a breeding program. SHD farmers are generally limited in their choice of semen, but Friesians are usually the breed of choice provided by the inseminators working for the dairy cooperatives, although, when available, AFS semen is very popular. It may be worthwhile trying to source semen from other dairy genotypes, such as Jersey or Brown Swiss, to compare with Friesians. Advice from your semen supplier should be sought.

If AI is not available, the only choice is natural mating, and in many cases that requires each farmer to have his own bull. This limits the genetic improvement possible compared with AI because the bull is likely to be locally bred and of poorer genetic merit than bulls used to supply semen. Bulls are quite expensive for a small holder farmer to own, so, provided there are sufficient dairy farmers in the area, and the owner of a good quality bull is agreeable, using a common bull may become an option. If this is possible, it is important for a veterinarian to check the reproductive health of any herd bull.

Bulls are generally better than humans at picking out any cow on heat. Provided the bull is fertile, its reproductive performance is likely to be better than an inseminator, particularly if he only has a limited number of cows to inseminate in his area. Lack of potential inseminations each year can severely limit inseminator skills. Tropical climates can also reduce the ease of detecting when cows are on heat.

The impact of AI on the genetic improvement of national herds can be very low. For example, in Sri Lanka, despite the extensive use of AI, over 65% of the progeny result from natural services, mainly from scrub bulls. This is attributed to the poor infrastructure of AI services in the country, as well as the lack of farmer confidence that AI will result in a pregnancy.

There are several relatively new reproductive developments that SHD farmers may be aware of. Oestrus synchronisation is hardly relevant for the small holder, while embryo transfer is much too expensive to consider. Single sex semen is still expensive but in years to come, it may become sufficiently cheap to be an economic option.

Genetics is all too often given too much emphasis in the future development of SHD herd-management programs. Nutrition is by far the greatest constraint to farm milk production and profits. For AI to have much impact on the genetic improvement in many developing countries, farmers and government or dairy cooperative inseminators require considerably more training in reproductive management.

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