Animal breeding

in organic farming

Discussion paper

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Foreword

This discussion paper was written for the vision building project "Organic breeding, a long way to go" which is carried out the Netherlands. In this project, we aim to make succinct choices with regard to animal breeding in organic agriculture, as well as an action plan to realise an appropriate system of breeding. The purpose of this discussion paper is to facilitate a broad discussion with organic farmers and other stakeholders, such as breeding companies, interest groups and policy-makers.

The vision project builds on Klarita Varenkamp's pioneering work for Louis Bolk Institute, which culminated in a biodynamic vision on breeding (Varenkamp, 1997). The discussion paper before you is the result of an extensive study of the literature as well as discussions and interviews with organic farmers and breeding organisations in the Netherlands. In addition, scientists from various disciplines with roots in both conventional and organic agriculture contributed their specific expertise.

The project team is made up of Wytze Nauta MSc. (breeding and livestock scientist, Louis Bolk Institute), Dr. Ton Baars (Head of Livestock Section, Louis Bolk Institute), Dr. Ab Groen (senior lecturer, Breeding and Genetics Group, Wageningen University), Rudolf van Broekhuizen MSc. and Dr. Dirk Roep (both lecturers with the Rural Sociology Section, Wageningen University) and Dr. Roel Veerkamp (breeding scientist, ID-Lelystad).

The project team has received valuable support from the members of the advisory committee: Prof Dr Pim Brascamp (Breeding and Genetics Group, Wageningen University), Dr Hans Schiere (International Agricultural Centre, Wageningen), Prof Dr Elsbeth Noordhuizen-Stassen (Special Chair for Man-Animal Relationships, Utrecht University), Dirk Endendijk (FH breeder, chair of the Dutch FH Association and farmer), Age Opdam (breeder and farmer) and Dr Henk Verhoog (ethicist, Louis Bolk Institute).

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Wytze Nauta
Project head

Summary

Organic agriculture is growing fast. Between 1993 and 1998, the total area under organic agriculture in Europe increased by almost 30%. It currently covers about 3.8 million hectares, or 3% of the total agricultural area. In the Netherlands, this is 1.4%. The sector's current and predicted growth can be attributed to the high public appeal of organic farming's principles. There is a risk, however, that for lack of available alternatives the sector will turn to more conventional methods in order to achieve the growth that the market demands, thus compromising its identity. In the light of this, it is vital that the sector continues to invest in its own qualitative development. There is currently much debate about the course of the organic agri-ecological system and the type of breeding that would best fit this system.

It is uncertain whether animals which have been bred for conventional production are capable of optimum performance in organic conditions. In conventional agriculture there is a movement towards maximum control of production conditions in order to optimise animals' yield in intensive production systems. By contrast, organic agriculture is based on natural processes and closed cycles, and takes into account the underlying connections between production factors. Following organic ideology, production capacity should be curtailed by acting in accordance with guiding principles such as naturalness, animal welfare, efficient use of fossil fuels in the farm cycle, and agri-biodiversity (IFOAM, 1994). Organic production should be tied to the land, with farms preferably being self-sufficient mixed farms with closed cycles.

An additional point of concern are the reproduction techniques used in conventional breeding. Artificial insemination (AI) and embryo transfer (ET) are commonplace in conventional animal breeding. But these techniques are 'artificial' and they deprive animals of natural mating behaviour and negatively affect the animals' welfare and integrity. By bringing in animals from conventional agriculture, organic farmers are indirectly making use of these techniques. These and other concerns have led to the project 'Organic breeding: a long way to go', which aims to lay down clear visions and an action plan for an organic breeding system.

Technological developments such as quantitative genetics, and reproduction technologies have helped transform animal breeding from a small-scale farm or regional activity into a global system. The metamorphosis of the dairy sector in the 1980s is also largely due to the introduction in of the *Holstein Friesian* breed. In fifty years' time, milk yields rose incredibly, for example in the Netherlands with 57% to over 8000 kg milk per lactation in 1999. Animal breeding, whether of cattle, pigs or poultry, is currently dominated by multi-national companies. Breeding programmes are more and more carried out on a nucleus basis. In pigs and poultry purebred lines are used to produce crossbreeds for the market. These crossbreeds are geared to production: in a conventional system, hybrid pork pigs grow an average of 840 g per day, while laying hens can produce a laying rate up to 95%.

For years, the organic sector was very small and mostly made up of biodynamic farms. The development towards a sector which encompasses various kinds of ecological production began in the 1980s and the sector has continued to grow steadily ever since. The principles of organic agriculture are laid down by the International Federation of Organic Agriculture Movements (IFOAM) and in European Commission's regulation 2092/91. The guiding principle which lies at the root of these organic regulations is the coherence between natural processes. This principle explains the importance of maintaining soil fertility and a preventive approach to crop health and animal health in organic farming. It is also the reason that independence, in the form of closed cycles, rates so highly in the organic sector.

As in conventional farming, different approaches to the system are developing in organic farming. There are farms involved in large-scale production of ingredients for industrial processing. The extra return on organic products is their motive for complying with the organic criteria laid down by law. Next to this fast-growing pragmatic approach is a large group of farmers who are motivated by the wish to realise a

responsible agri-ecological system, i.e. production tied to the land at farm level or regional level, closed cycles and minimum inputs. A third, smaller group is primarily concerned with the integrity of the production system and of the animals within the system. Their principles are an explicit consideration in their manner of farming. Our interviews with organic farmers reveal that each stream has a need for animals which are optimally adapted to the specific type of farm management.

The wish for a breeding system which meets the needs of organic agriculture requires discussion of several aspects. First, there are several ethical objections to modern reproduction technology. AI is included in our discussion of this subject, as some of the arguments against ET also apply to AI. An important objection to AI and ET is that it lifts reproduction out of its natural context. There is no contact between the animals during the act of reproduction. Semen, ovaries and / or embryos are subjected to large fluctuations in temperature. Research has shown a link between ET and an increase in embryo mortality and birth problems. *In vitro* culture techniques followed by ET increase the chance of deformities and postnatal mortality in calves. Moreover, these techniques are a stepping stone to sex determination of semen and embryos, cloning and the genetically alteration of animals. All this forces the question whether organic agriculture can accept continued use of a breeding system which integrates such techniques. If the organic sector wishes to restrict its use of these techniques, however, it must realise the impact of that choice on the accuracy and intensity of selection, two important factors in realising genetic progress.

The second category of concerns relates to estimated breeding value. Animals can be compared and selected at a young age on the basis of ancestry. This might lead to a preference in the selection process for early maturing animals. Also quantitative genetics take a reductionist view, as it reduces an animal to a number of quantitative traits, in contrast with the more holistic view of animals in organic farming. Some organic farmers deliberately select on the basis on an animal's own lifetime production in the assumption that this ensures the selection of all the necessary traits needed for production. Conventional breeding, too, is starting to weigh functional characteristics such as fertility and lifespan more strongly in estimated breeding values. Including such functional traits also leads towards selection of lifetime production, is the meaning of several breeding organisations.

The third category of concerns relates to genotype by environment (GxE) interaction. Are the traits selected in conventional breeding still relevant to and comparable in organic agriculture? As yet, there has been no scientific research into differences in GxE interactions between conventional and organic agriculture, but the hypothesis is that these differences do exist, especially with respect to functional characteristics and when differences between the two types of production are greater.

The primary traits and goals of breeding depend to a large extent on developments in and approaches to organic agriculture and the hypothesized GxE interaction. Farms with overlaps with conventional farming will probably make more use of conventional breeding than more idealistic, principled farmers. The greater the differences between systems, the less likely desirable characteristics are to be the same.

Finally, breeding also has a socio-economic aspect. Breeding is a hobby of many farmers, specially in dairy farming, that also lends one a certain status among fellow farmers. Breeding for organic agriculture supports the individual, farm-specific character of breeding and is less dependent on conventional institutional structures. In this way, organic agriculture can ensure more diversity within breeds and encourage the use of local breeds.

At the end of this report, we present a number of possible future scenarios based on facts and developments in the field of breeding and in organic agriculture. The scenarios are presented in a sequence from most pragmatic to most congruent with organic ideals. The scenarios are intended to help participants in the discussion on breeding focus on the different bottlenecks and possibilities. The two ends of the scale are made up by a worldwide breeding system on the basis of quantitative genetics on the one end, and regional breeding based farm-specific breeding on the other.

The principles of more organic based breeding strategies for the different animal species can be the same. However, current practices in breeding cattle, pig and poultry are different. Cattle breeding is still an open system and organic farmers can still choose their own breeds and strategies. Current pig and poultry breeding is more or less the exclusive domain of international breeding companies providing farmers with hybrid animals. Therefore, realising more organic based breeding strategies for these species will present a major challenge. Nevertheless, there are possibilities which can be explored.

Table of contents

1. Introduction

The scale of organic agriculture has increased rapidly in the last ten years. People nowadays are more concerned about their own health (Pollan, 2001) and about the health of our environment and our nature areas; concerns which have resulted in a greater demand for organic food (De Wit and Van Amersfoort, 2000). There are now more than 129,000 organic farms in Europe (SÖL, 2001), which together cultivate 3% of the total area under agriculture. In the Netherlands this is 1.4% and 42% of these farms are involved in livestock production. Dairy farms have the largest share in organic livestock production in the Netherlands, although the numbers of pork and poultry producers are growing.
The regulations and standards governing organic agriculture have evolved from regulations for manure application and crop growing to now include standards for animal production as well (EU, 2000). An important aspect of the EU's regulation for organic livestock production is the origin of the animals. Officially, brought in animals from a conventional source may not exceed the yearly maximum of 10% of all animals of the same species on a farm (IFOAM, 2000). The practical interpretation of this rule is that the animals concerned should not be purchased directly from a conventional farm or breeding company. When conventional animals are kept under organic circumstances for a certain period of time, they are considered organic. In this way poultry farms can restock with conventional animals which are reared organically. The regulations only address the bringing in of conventional animals as stocking material. Through the use of AI, however, organic dairy and pig farmers are bringing in up to 100% conventional stock. The concerns, however, are more in the field of the genetic origin of the animals, while all the animals are selected for the conventional farming systems.
It is the genetic background and the technologies used in modern conventional breeding which raise questions with farmers, breeders and consumers. Until now, there has been very little in the way of structural thought towards development of a common position as to what type of breeding would be desired, which breeding methods are needed, which breeding goals suit organic and related aspects such as diversity, animal welfare and naturalness of breeding.

Concerns about the use of conventional breeding stock fall into three main categories: ethical concerns, agri-ecological system related concerns and reservations regarding technical aspects of breeding.

From an ethical viewpoint, there is the question to what extent animals may be used for production without regard for their welfare and integrity. IFOAM's guidelines for animals in organic production systems are clear (see appendix 1: IFOAM Animal Production). Animals may not be produced using embryo transfer techniques (ET). Animals must be able to adapt to local conditions, thus ensuring diversity. Animals must be able to function in a system which is defined by organic principles such as naturalness and animal welfare. And finally, animals may not be mutilated (IFOAM, 2000).

In particular, modern reproductive technologies and ever more advanced selection are putting the integrity and welfare of animals at stake. Unless certain technologies (ET) are banned in organic farming, the indirect use of these techniques is unavoidable as they are commonly used in conventional breeding, especially dairy breeding. New technologies are being developed like marker assisted selection (MAS), sexing of sperm and maybe genetic engineering. These techniques make the use of conventional breeding stock in organic farming questionable or even controversial.
Another ethical concern is the lack of variation in breeds. Most dairy farmers in the Netherlands have Holstein Friesian cows (Elbers and Nauta, 2000), while pig and poultry producers are dependent on a few conventional hybrids or brands (De Wit, 2001; Bestman, 2000). In other western countries practices are expected to be the same. The low variation can be dangerous for the maintenance of the species.
Animal welfare is at stake if animals selected for conventional conditions can not cope with an organic situation. These animals have a very high genetic predisposition for production and therefore need high quality feed and concentrates. These are not always provided on organic farms. This can lead to health and fertility problems and more intensive veterinary management. Furthermore, conventional animals

sometimes lack characteristics which are desirable in organic systems. For example, modern pig breeds have very little body hair and a short snout, which makes them less capable of coping with sun and heat in an outside run. They also have relatively little body fat to protect them from the cold (Van Putten, 2000). Holstein cows have long, dangerously formed horns which increase butting injuries (Baars and Brands, 2000; Waiblinger et al., 2000). In hens, negative pecking behaviour and cannibalism occur (Bestman, 2001; Hierden, 1997; Kjaer and Sorensen, 1997). In conventional agriculture, animals are mutilated to prevent the onset of such undesirable behaviour or characteristics. In principle, mutilations are banned in organic farming as it compromises animals' welfare and integrity.

The second category of concerns stems from the fundamental differences between the agri-ecological system upheld by organic agriculture, in which ideally animals should be adapted for optimum performance at a specific farm, and the conventional system, which is adapted to meet the needs of high-yielding animals and leads to standardizing of farming systems and the loss of diversity . Should organic agriculture adopt, to some extent, conventional practices ? Some change is already being seen in the approach to organic farming. Farms are scaling up and specialising, which necessitates large inputs of bedding and feedstuffs. Other farms are developing more as an agri-ecological system with closed cycles and minimum inputs (Verhoog et al., 2001). Therefore, the type of animal or traits needed in organic farming depends on the development of the organic sector in general. A more rational, specialised and industrialised approach will certainly do well with conventional breeding stock. But a more 'true organic' approach will certainly challenge today's breeding strategies.

With respect to aspects of breeding, there are concerns about diversity, GxE interactions and the impact of reproduction and selection techniques. The high yields being realised in conventional farming appear to be exclusive to the breeds and crosses provided by conventional breeding. As yet, there is no scientific evidence of differences in GxE interactions between conventional and organic agriculture, but this does not preclude the possibility that they might play a role in the expression of conventional genotypes in a deviating, organic, environment. The widespread use of reproduction technologies may lead to the loss of natural fertility. A ban on embryo transfer (ET) and related technologies might have a strong effect on the existing selection systems and genetic progress. A complete ban would diminish the number of breeding bulls which can be used by organic farmers.

The selection techniques themselves are questionable with respect to efficiency, speed and reductionism. For example, the speed at which high accurate estimated breeding values of young animals are available may lead to the selection of early maturing animals. Finally, from an organic and holistic point of view it is questionable if an animal can be selected on the basis of a small number of characteristics.

Adapting the animal to the environment, or the environment to the animal

Breeding was an important part of the enormous technological push made by conventional agriculture in the last forty years (Van der Ploeg, 1999; Roep, 2000). Production has become highly specialised and increased tenfold, per animal as well as per hectare. Production conditions have largely been standardised (housing, feed). Production levels have reached an economic optimum thanks to synthetic chemical fertiliser, pesticides and cheap imports of feed ingredients. All this can be put down as adapting the environment to the highly productive animals.

By contrast, the roots of organic production lie in natural processes and closed cycles, and taking into account the underlying connections between production factors. Following organic ideology, production capacity should be curtailed by acting in accordance with guiding principles such as naturalness, animal welfare, efficient use of fossil fuels in the farm cycle, and agri-biodiversity (IFOAM, 1994). In the early days of organic agriculture, every effort was made to ensure that organic production was tied to the land, that farms were self-sufficient mixed farms with closed cycles. Acting in accordance with these guiding principles, each farm selected its own animals for breeding towards the ultimate goal of animals which were optimally adapted to the specific conditions of the farm.

The growing gap
As organic agriculture grew in the 1980s and 1990s, so did conventional breeding: embryo transfer became widely available and breeding strategies combined with new housing systems produced impressively high-yielding animals. This raised concerns in organic circles about the genetic suitability of conventionally bred animals for organic production. In the late 1980s, there were small initiatives by organic dairy producers to set up organic breeding based on line breeding and on-farm breeding (Baars, 1990b), but until now this has not resulted in a comprehensive organic approach to breeding. With organic agriculture now enjoying explosive growth and great popularity with the public and policymakers, it is vital that the sector works on further qualitative development. The fast pace of technical developments in conventional agriculture underscore this urgency. Genetically modified animals are not yet being used, but cloning, sexing and marker selection are slowing being incorporated in breeding (Brascamp, 1992; Rotschild, 1998; Seidel, 1992).

In addition to ethical and technical concerns is the question of image: can organic agriculture afford to continue to use conventional breeding? Some consumers demand 'real organic', products which they perceive as being truly natural and made with respect for animals (De Wit and Van Amersfoort, 2000a). Organic agriculture must also earn its licence to produce. IFOAM and European standards for organic products state that organic livestock production should use 'organic' stock wherever possible (EU, 2000; IFOAM, 2000). The new food safety policies of traceability also demands closed cycles in which products and their constituents can be followed every step in the chain from farm to fork (Wijffels et al., 2001).

The sum of it is that many organic farmers in the Netherlands are unhappy about their current breeding choices (Nauta, 2001). In other countries this was not yet researched but feelings are probably the same. The gap between conventional and organic agriculture is becoming wider and wider. Yet developments are taking place on both sides of the gap which might be significant in the discussion on breeding (see boxes) and should therefore not be overlooked.

Changes in organic and conventional agriculture
Public opinion is forcing conventional agriculture to rethink its strategy with respect to the environment and animal health and welfare, aspects which are also of primary importance in organic agriculture. In this respect, conventional agriculture is starting to resemble organic. A differentiation is developing in conventional agriculture from large-scale factory farming at one end to multi-functional agriculture, in which farming contributes to rural development in a variety of ways, at the other end (Frouws and Van Broekhuizen, 2000). It is this multi-functional form of agriculture which has considerable overlap with organic agriculture.

A similar process of differentiation is taking place in organic agriculture. New styles and streams are emerging. Verhoog et al. (2001b) identify at least three categories based on a producer's view of naturalness as the primary shaping force of organic farm management. These views, broadly speaking, relate to the use of chemicals, the agri-ecological system or integrity. Regardless of whether they are organic or conventional, farmers' breeding wishes and needs are strongly determined by their view on farming and management (Groen et al., 1993; Verhoog et al., 2001b).

Goal

The vision project 'Organic breeding' was born of farmers' uncertainties about breeding and the many concerns about breeding in organic agriculture in general. The objectives of the project are:

1. To lay down visions on the possibilities and limitations of a breeding system which respects the principles of organic agriculture and the diversity of viewpoints within the organic sector.
2. To provide a discussion report to direct and support discussions on breeding.
3. To develop an action plan for an organic breeding system supported by the organic sector.

The publication of this report rounds off the first part of this project and paves the way for a series of discussions on breeding, ethical implications and the course of the agri-ecological organic system.

Method

Louis Bolk Institute's method of conducting research is characterised by a participatory approach: its projects in organic agriculture are carried out in cooperation with farmers who are considered pioneers in their field (Baars and De Vries, 1999). This discussion paper is based on interviews with primary producers and other stakeholders, a study of the literature and the pools of knowledge within Louis Bolk Institute and Wageningen University and Research Centre (Rural Sociology Group, Animal Breeding and Genetics Group, and ID-Lelystad). The topics for discussion presented in this report are the result of an analysis in the Netherlands of the current situation and developments in breeding in the light of the principles and methods prevailing in organic agriculture. The report is most strongly focused on dairy cattle, as dairy production by cows is the largest livestock sector in the Netherlands. Pig and poultry production and the difficulties and opportunities in these sectors are only briefly discussed. Although each sector has its own specific problems, the same general approach might serve for all these sectors (see chapter 5).

The discussion paper is intended as a basis for the discussion and evaluation of ideas on breeding in organic agriculture, both in the Netherlands and in other countries. To this end, Louis Bolk Institute has published a Dutch and English versions of the discussion paper. Discussions will take place with organic farmers in study groups and workshops. The outcome of these discussions will be presented in a final report, which will also contain an action plan for the development of an organic breeding system.

A guide to reading this report

The report is mainly based on Dutch research and circumstances, but many aspects are also relevant to other western countries. Chapters 2 and 3 give detailed information on breeding and organic agriculture, respectively, and are included for reference and as a crash course for those who are not well acquainted with one or both fields. The points at which conventional breeding and organic agriculture grate are described in chapter 4. These difficulties concern reproduction techniques, selection techniques, genotype - environment interactions, socio-economic aspects, inbreeding and agri-biodiversity, animal welfare and animals' integrity. Possible scenarios and approaches to resolving these difficulties are presented in chapter 5.

2. Developments in animal breeding

In this chapter we give a definition of selective breeding and briefly describe the history of this activity. In the last century, selective breeding has evolved from a regional activity to the worldwide exchange of genetic information. It owes this development to breeding technologies which are becoming more and more advanced and at the same time more and more controversial for organic farming. A good understanding of past and current issues and strategies in selective breeding is imperative in order to make a useful contribution to the discussion on breeding for organic agriculture.

2.1. Definitions of selective animal breeding

Selective breeding means different things to different people. In general, we can define selective breeding as:

the directional mating of parent animals in order to obtain progeny which best meets the wishes or breeding goals of the breeder.

Typically, each breeder has his own preferred set of breeding goals. In many cases, breeders' selections are determined to some extent by an individual preference or fancy. Every breeders or breeding organisation has its own perspective on animals and its own vision on how to achieve the set breeding goals. The goal of dairy farmers, for example, is to have a herd which produces milk to the quota maximum in the most efficient manner. Efficiency depends however on the specific circumstances of each farm. Thus, a high or low yield per cow depends on such variables as milk per hectare (Van der Ploeg, 2000). Breeding goals of breeding organisations are based on current circumstances and future outlooks for farming. In the past, economic aspects were the primary consideration, in particular market prices. These days, the breeding goal also takes into account ecological and socio-economic aspects. A broader definition of selective breeding of livestock is as follows:

the aimed selection of parent animals to produce a new generation which can produce more efficiently than their parents in the given production conditions and economic, ecological and social-cultural context.

2.2. Selective breeding strategies

Traditionally, breeders have used one of three selection strategies (Simm, 1998): selection between breeds, selection within a breed, and crosses between breeds or of lines within a breed.

Selection between breeds

Breeds can differ strongly with respect to production traits. The selection of a certain breed over others may bring about an impressive improvement in the herd on certain traits. Breeders, however, rarely cull their entire herd for animals from another breed. More commonly, the new breed is introduced through cross-breeding. This type of cross is referred to as upgrading. An example of upgrading in conventional farming was the displacement of the Dutch Friesian breed by more productive Holstein Friesian breed. Farmers may exchange one breed for another in response to a drastic change in conditions on the farm, caused for example by conversion to organic production. Currently, many organic dairy farmers in the Netherlands are crossing their Holstein herds with the more robust Brown Swiss or Montbéliarde breed.

Selection within a breed

The selection within a breed involves comparing potential breeding animals on desirable traits. The best animals are mated in the assumption that their progeny will be superior to their parents. This type of selection may be carried out within large populations (the worldwide HF population) or smaller populations (FH breeding in the Netherlands). As long as there is enough genetic variability, this type of selective breeding will yield progeny with additional qualities compared to their parents. Inbreeding is used to a varying degree in order to obtain better purity of type. Breeding organisations use quantitative analyses of data in order to select the animals in the population with the best breeding values. By contrast, individual breeders select and mate animals from their own herds or select sires from the breeding stock of commercial organisations.

Crossing

Crosses can be made between breeds, between lines or between families. In pig and poultry cross breeding of pure lines is common practice (Merks, 2001a; Sorensen, 2001). In this way, they benefit from a non-additive genetic effect called heterosis. Also called hybrid vigour, heterosis is the phenomenon that cross-bred animals perform better than would be expected from the mean performance of both parents. The heterosis effect differs per combination. Information about the results of crosses or hybrids is used to select lines in a system of Recurrent Reciprocal Selection (RSS) (Flock, 1999). This selection technique utilises heterosis as well as the additive genetic effect.

Crossing is usually used to obtain production animals which will not be used for breeding. In pig and poultry production, the production animals are usually of the F2 generation and result from a three-way or four-way cross. Breeding sows can be purchased as F1 sows or produced by rotation crossing at the farm. The breeding sows are crossed with a boar from another line to produce porkers.

As yet, crossing is not a common technique in cattle breeding. In organic dairy production, however, more and more herds contain first crosses with breeds such as Brown Swiss, Montbéliarde or Blaarkop (Elbers and Nauta, 2000). Some farmers do not want to 'mongrelise' beyond the F1 cross which have excellent vigour and persistence. In California a rotation cross trial has now started with the aim of alleviating fertility problems in dairy cattle. In the past, crosses of FH cows with HF bulls in the Netherlands produced many excellent dairy cows with a lifetime yield of 100,000 kg milk or more (Veeteelt, 2001c).

In breeding circles, there is always some about who is a true breeder. Many 'elite' breeders feel they are the only true breeders because they are focused on improving traits within a breed (Baars, 2001). This report, however, also applies to the selective breeding of animals in order to obtain production animals, which can be done using any of the three strategies described above. For example, progeny of upgrading (1) will always have more genes of the new breed. The process of displacement takes a few generations upon which the breeder will have reached his goal. Selection within a breed (2) is a constant quest for the best combinations in order to reach the desired breeding goal. This breeding goal depends largely on the individual ideas and fancies of the breeder, but also on the dynamics of changing production conditions. This makes breeding an ongoing activity. In the crossing strategy (3), heterosis interferes with the additive genetic effect. Yet crossing is a complex art, too, because the right combinations yield the best progeny. In that sense, it strongly resembles breeding. Crossing breeds or lines could be called one-step breeding because the end product is produced with one cross. The RSS method uses feedback about the progeny of a cross to further develop the parent lines.

The three strategies are often interchanged. In upgrading, a breed may be used which has changed due to within-breed selection by other breeders. Within-breed selection may also use animals which result from a cross between families or lines (Bakels, 1988).

2.3. How selective breeding started

Herdbooks describing breeds were first published at the end of the 19th century.

Before then, people have been breeding animals to suit their purposes for centuries (Idel, 1993), probably without common breed descriptions. When people first began to farm, animals were mostly kept for grazing and eating waste products. The manure was used to fertilise crops. Over time, varieties of soil type and climate led to different types of animals which were highly adapted to local conditions (Hengeveld, 1865). This relationship between soil and animal did not change until the invention of synthetic chemical fertiliser in the 19th century. Arable production and livestock farming became less dependent on each other. As a result, the husbandry and selection of animals became more focused on the production of meat, milk and eggs.

Robert Bakewell (1725-1795) of England is often called the pioneer of organised selective breeding of production animals on the basis of trait analyses. He bred sheep and hired out his rams to other farmers in his area, then toured these farms on horseback in order to scrutinise the progeny (Simm, 1998).

The pioneer of the modern science of genetics is Gregor Mendel, who achieved experimental crosses with peas in the 19th century (about 1865). He found that every trait was determined by a factor of the father plant and a factor of the mother plant. Mendel's findings were confirmed by other scientists early in the 20th century. This led to large-scale research into the chemical properties of the carriers of hereditariness. In 1953, Watson and Crick identified DNA as the carrier of hereditary traits. This fundamental fact resulted in the development of a genetic model on which modern quantitative breeding is based (see box). It should be noted, however, that quantitative genetics is older than the discovery of DNA (Hazel, 1943).

According to the genetic model, traits or characteristics are laid down in the genes in DNA. Desirable traits can be fixed and retained in populations through selective mating. Marker selection technology can identify genes directly. Genes which are known to be associated with a trait can thus be localised in the DNA and used as information in the selection.

Genetic model

An animal's genetic disposition is contained in its DNA, half of which is passed on by the father and half by the mother. DNA has a very complex structure. Some parts of DNA, the genes, contain codes for proteins which play a role in the metabolism of an animal. The DNA of mammals contain thousands of genes. Mammals are diploid. That means that they have two homologous copies of each gene, one from the father and one from the mother. Genes exist of different variants, called alleles. All the alleles of one gene code for a protein with the same function. The alleles themselves may differ, for example in the rate that enzymes are formed or in the enzymes' structure so that they function at different speeds. Briefly, the influence that alleles may have on a metabolic process can be one of:

- Additive: independently of other alleles on the homologous gene or on other genes in the animal's DNA;
- Dominance: dependent on other alleles on the homologous gene; [the property of one of a pair of alleles that suppresses expression of the other in the heterozygous condition]
- Epistasis, or interaction effect: dependent on other alleles on other genes in the animal's DNA [suppression of the effect of a gene by a nonallelic gene]

The genotype of an animal can be expressed as $G = \text{mean } G + A + D + E$.

In the conventional method of estimating breeding values, the EBV reflects the additive genetic effect. This is considered to be an operational model.

2.4. Development of quantitative breeding

Herdbooks, the registration of livestock data and the desire to boost the genetic progress for milk production led to the development of quantitative breeding. In quantitative breeding, selected characteristics of progeny is quantitatively recorded and the data is used to estimate breeding values of the various characteristics for the parent animals. These parent animals can then be selected on the basis of their EBVs.

Breeding goal

Breeders aim for animals which will be able to produce efficiently in future production conditions. To this end, their breeding goal consists of important characteristics or traits for these conditions. Each of these traits is expressed as a breeding value and assigned a weight depending on its relative importance. The breeding goal can be expressed quantitatively as the sum of breeding values multiplied by their respective weights:

$$\text{Breeding goal} = w_1*bv_1 + w_2*bv_2+\ldots w_x*bv_x$$

Estimated breeding value (EBV)

A breeding value expresses an animal's genetic predisposition for a certain trait. The breeding value cannot be measured directly; it must be estimated from phenotypic performance. Phenotypic performance is the interaction of the trait with the animal's production environment. In the estimation of breeding value, the Best Linear Unbiased Prediction model (BLUP) is used which also corrects for the influence of the environment. The value of the EBV depends on the quantity and type of information as well as the source of information. Large quantities of information and a high heritability (h^2) increases its accuracy, or statistical reliability. Milk, for example, has a heritability of 0.35. In order to obtain a reliability rate of 90%, first-lactation data must be collected for 100 daughters distributed over 50 farms. The lower the heritability, the more information is needed for a reliable EBV. For example, many health traits have a h^2 of about 0.10, which means that data on 400 daughters is necessary for a reliable EBV.

EBVs are nowadays calculated by using the Animal Model.

Animal Model

The Animal Model can be used to estimate breeding values for a wide variety of traits. It enables the comparison of all male and female animals in a breeding region and is used for the simultaneous estimation of breeding values of male and female animals. The breeding value estimation of female animals can be based on the animal's own performance as well as all other relatives available. In dairy farming, because of the wide scale use of AI and ET technology, animals from the same families are distributed over many different farms and also half and full sibs are available. Data on relatives' performance in these different conditions improves the accuracy of the index rating. Data on both living and slaughtered animals is included. The relative weight of the animal's own performance in the index thus diminishes, correcting for possible interference of preferential treatment.

The Animal Model can incorporate data from all degrees of relations in the estimation of breeding value. Estimated breeding values can be pooled for an index such as the Dutch Inet or DPS (see box below). In an combined index, breeding values are weighted according to their importance.

Inet and DPS

In the Netherlands, dairy animals are given an Inet value (net milk money index), which is calculated using the animal's estimated breeding values (EBV) for kg of milk, fat and protein:

$$\text{Inet} = -0.15*\text{EBV}_{\text{milk}} + 2*\text{EBV}_{\text{fat}} + 12*\text{EBV}_{\text{protein}}$$

The EBVs are based on empirical milk production data which is obtained from milk recording organisations. The multipliers -0.15, 2 and 12 are the weighing values. The Inet value is also combined with an estimated breeding value for durability (DU), which is based on direct observations of productive life traits and indirect aspects such as cell count and functional conformation traits. The durable performance sum (DPS) is calculated per animal as follows:

$$\text{DPS}_i = 1 * \text{Inet}_i + 15*\text{EBV}_{\text{DU,I}}$$

Traits

Before a selection of desirable traits can be made, it is important to have a list of traits as they relate to production efficiency in given conditions. The list for conventional farming contains a number of composite traits which are based on groups of quantitative and predictive traits. The European Association for Animal Production (EAAP) maintains the following list for conventional dairy animals:

Composite trait	Traits	Predictive traits
milk production	milk in kg fat in kg or % protein in kg or % milk quality	e.g. . κ-caseïne or somatic cell count
meat production	growth or final weight dressing % fleshiness fat thickness	
birthing	course of parturition ease of calving stillbirths	
fertility	regular heat fertilisation rate	no. of open days, calving interval, non-return %
udder health	clinical infections sub-clinical infections	udder depth, position of teats, fore udder attachment, somatic cell count, milking speed
leg and claw health	clinical and sub-clinical problems	claw and leg conformation traits, gait
handling	milkability temperament	
functional lifespan biological efficiency	body weight feed efficiency metabolic stress	fitness score energy balance persistence of milk production

Table 2.1 EAAP list of breeding traits for dairy cattle

Quantitative breeding programmes enable the comparison and rapid evaluation of animals on their genetic merit. Therefore, breeding programmes have been optimised and nucleus breeding is also introduced in dairy breeding. Per year, hundreds of bulls can be tested and data on first lactations alone gives breeding organisations enough information in order to determine a bull's average breeding value for various traits, in relation to the average genetic merit of the population. For any trait, farmers tend to use bulls with the highest EBV, so that genetic progress in the population is rapid.

Quantitative EBVs and advanced reproduction technologies together make for a fast achievement of a general breeding goal and enable breeders to respond fast to changes in market demand. Genetic marker technology will give yet another boost to breeding efficiency. A genetic marker might even be a direct selection criterion if the correlation is high enough. In that case, animals could be selected at a very young age, even in the embryonic stage. The generation interval would be reduced considerably.

Most data for breeding purposes is collected nationally. Bulls are attributed a breeding value on the basis of the national population. However, international genetic evaluations can be obtained using a complex statistical method (MACE: Multiple Across Country Evaluation) incorporating bulls' performance in different countries. These international evaluations can then be converted back to breeding values for national use (Interbull, 2000). With this method, foreign bulls can be reliably selected for national production conditions. This method has expanded breeders' pool for genetic source material to encompass the entire world.

When selective breeding is conducted on a worldwide scale, breeding values can be distorted by GxE interactions. Trait measures can thus represent different traits depending on the conditions (see box on GxE interaction). One option to minimise these differences is to standardise production conditions as much as possible. Between countries, differences have been found with correlations of 0.7 to almost 1.0 for production traits (Interbull, 2000). Quantitative information on differences in functional traits is not yet available. Organic and conventional conditions also differ, so that GxE interaction may distort breeding values at this level, too. Research into this type of GxE interaction is yet to be carried out.

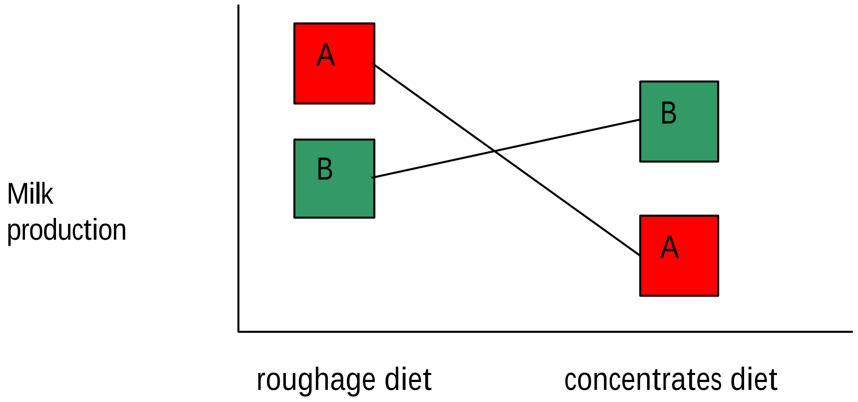
Highly accurate methods of estimating breeding values make it possible to select for more traits. Health and durability traits are now more and more incorporated in the indexes. In the Netherlands the last ten years, breeders have started providing EBV's for udder health (mastitis), fertility, ease of calving, and most recently, body weight. This gives farmers a better choice: they can draw up their own list of desirable traits and buy breeding material accordingly.

Because only the best sires are used in modern global breeding, the global population of dairy cattle descends from only a handful of cow families. There is now a real risk of excessive inbreeding on a global scale. In the Netherlands, inbreeding is increasing by 0.1 to 0.2 per cent per year, while this rate should preferably be less than 0.1% (Groen, 1998 and 2001). To counter this development, breeders have developed a programme to determine the optimum number of bulls with different bloodlines (Bijma, 2001; Veeteelt, 2001a). This does not alter the fact, however, that farmers who participate in global selective breeding still obtain their breeding material from the same pool of bulls, ultimately yielding highly uniform herds. The variability within the population thus continues to decline.

Genotype by environment (GxE) interaction

An example of GxE interaction, the robust cow A performs better on roughage rations while the lean milk type cow B does better on a diet which is high in concentrates.

The estimated breeding values of bulls in different production systems can be seen as representing different characteristics: milk production on a diet of roughage is not the same as milk production with a high concentrate diet. GxE interaction can explain changes in production indexes of bulls between different production environments. The correlation coefficient of the EBVs in two different production systems are a measure of the GxE interaction. Such correlations are also calculated by Interbull for its international genetic evaluations.



GxE interaction is sometimes interpreted as whether or not a bull is appropriate for a given type of farm or for given conditions. Statistically, this should be represented by a correlation coefficient for EBVs for different conditions. The estimated correlation coefficient for milk production between the EBVs of the US and Canada is 0.96 (ie. the same trait is being measured), but only 0.77 between Finland and New Zealand. Research in The Netherlands has demonstrated correlations of at least 0.95 between milk production on sandy soil, clayey soil or peat soils. Research is currently being carried out into the possibility of a GxE interaction effect between organic and conventional dairy systems

2.5. Developments in dairy breeding

Dairy breeding has developed rapidly since the 1950s and breeding is now considered by many to be too far removed from the principles and aims of organic agriculture. In order to develop a vision on breeding for organic dairy production, it is important to review the history of conventional dairy breeding. We must find out which crucial events have brought this about to stimulate the discussion towards vision development.

2.5.1. The structure of the dairy breeding sector

Cattle breeding today is a global activity. Unlike pig and poultry breeding, cattle breeding has an open structure. Breeding material is available for all who want it, as the progeny of breeding bulls are owned by independent farmers and can be sold or used for further breeding as they wish.

Before 1935 dairy cows were always served naturally by bulls. Breeding was a local activity dominated by so-called elite breeders: they selected the breeding bulls, which to breed on the farm and which to sell. The farmers who used the bulls from elite breeders formed a distinct group, the 'users' of the elite breeders' products. When the first two herdbook societies were founded at the end of the 19th century, the Dutch Friesian Cattle Herdbook and the Noord-Holland Cattle Herdbook, breed descriptions were drawn up and an animal registration system was developed.

Artificial insemination was introduced to the Netherlands in 1935 and gradually became both an important instrument and goal for breeding organisations. After AI was accepted by the herdbooks in 1942, AI organisations cropped up everywhere. By the late 1950s there were 160 AI organisations in the Netherlands which carried out 500,000 inseminations per year. AI enabled bulls to be evaluated on the performance of their daughters. As a result, the qualitative selection by elite breeders on the basis of their depiction of the ideal cow and desirable conformation was replaced by a more quantitative selection of bulls on the production and conformation merits of large daughter groups. The scale of breeding increased and breeding organisations merged as new technological improvements were introduced (the freezing of semen) and the rural infrastructure was improved. By 1978 only 49 AI organisations remained. In 1993, these joined forces to form three major regional AI units: North-West, East and South. These have since merged to form the national AI organisation CR-Delta, whose daughter company Holland Genetics carries out the actual breeding activities.

In addition to these AI conglomerates, there exist some smaller breeding and AI organisations like KI Kampen, KI Samen and Altapon. In addition to these Dutch-based breeding companies, other parties on the breeding market include semen dealers and importers such as WWS, Koole-Liebrechts, ALH Genetics and Impact Genetics. These businesses market both Dutch and foreign breeding stock. In general, dealers are an extension of breeding companies. Some dealers do some selection themselves, selecting sire mothers and selling the progeny. Some dairy farmers are also involved in this limited form of selective breeding.

The increasing economies of scale of the breeding and AI organisations went hand in hand with the gradual development of the young bull system. In this system, promising bulls are tested centrally on own performance and the performance of their first limited number of daughters (see section 2.4). The next generation of breeding bulls is obtained by crossing the best tested sires with sire dams selected from the population with the cow-index selection.

This breeding structure still forms the backbone of dairy breeding today in the Netherlands. The system has improved with the refinement of statistical models (see 2.4 and 2.5.), i.e. the generation interval has been reduced and data on full-siblings and half-siblings is used to achieve a faster, more reliable EBV. Fairly recently, large breeding companies have also started testing female breeding animals centrally, i.e. at breeding stations. Here, heifers are tested and compared in optimal conditions. ET and IVP are the main techniques used to propagate breeding stock. In this way, the breeding company can retain promising breeding stock for its own use in its own breeding programmes and form a semi-closed nucleus. The semen of breeding bulls is sold on the open market, however, so that individual breeders eventually do obtain these genetic qualities, albeit with some delay. This only serves to consolidate breeding companies' genetic lead. With large breeding companies playing a dominant role in cattle breeding, individual dairy farmers are being relegated more and more to the role of users.

2.5.2. The impact of reproduction technologies

The introduction of AI technology in 1946 brought about a revolution in cattle breeding. With AI and semen dilution, a lot more progeny, distributed over a larger geographical area, could be obtained from a single breeding bull. The freezing of semen also meant that progeny could be obtained beyond the active lifespan of the bull. This increase in reproduction capacity meant that fewer bulls were required to breed the next generation of breeding stock and the selection intensity increased. The importance of individual breeders declined rapidly. The ownership of bulls shifted from farmers to breeding companies, and information about the performance of sire dams became less important in the selection of bulls.

Another advantage of the increased reproduction capacity in conjunction with the wider distribution of progeny is the possibility of effective, accurate progeny testing. In order to test young bulls, progeny groups made up of animals from a wide diversity of farms can be formed in a short period of time. The intensive use of semen from these bulls is put on hold until the first results of progeny testing are available.

This additional selection possibility lies at the basis of the close cooperation between AI organisations and breeders. Considerable investments were made for the introduction of this so-called young-bull programme, in particular because a lot of young bulls had to be tested to obtain a sufficiently large selection pool and because the waiting period is costly.

In summary, AI enables more accurate and sharper selections in quantitative breeding and thus increases the rate of genetic progress. AI also lies at the root of the internationalisation of breeding and the possibilities this offers. A negative aspect of AI is that it has also led to the loss of genetic variability in the global dairy cow population and the worldwide domination of the Holstein-Friesian breed.

While AI increased the reproductive capacity of bulls, the introduction of embryo transfer, or more accurately Multiple Ovulation and Embryo Transfer (MOET), raised the reproductive capacity of individual cows. With MOET, about seven embryos can be collected from one cow every five weeks (see Appendix II for description of technique). MOET has intensified the selection of sire mothers. With MOET, breeders can be certain of obtaining male progeny from selected sire dams. Due to MOET, cows became more important in the breeding cycle. Breeding organisations sought to obtain potential sire mothers and house them at a central location in nucleus breeding units. This development further removed breeding from dairy farming practice.

The subsequent introduction of ovum pick-up and in vitro embryo production (OPU / IVP) continues the trend that started with MOET. OPU can be carried out on very young cows, significantly reducing the generation interval (Roelofson et al., 1994) (see Appendix II for description of technique). Further, with this technique, more selected matings can be organised in a short time while ova are collected and fertilised in vitro usually twice a week. The female progeny of sire mothers have become a marketable by-product of this reproduction technology.

The use of MOET and OPU / IVP technology in nucleus breeding programmes has culminated in a type of young-dam programme with an increase in both the intensity and accuracy of selection. The difference with the young-bull programme is a delay of one generation. With these technologies, At the beginning of the cow's first lactation, or even earlier, there is a sizeable progeny group in different stages of development, from embryo to foetus to live calves. During the first half of her first lactation, a potential sire mother's performance is tested. This information is combined with data from maternal sisters to supplement, or enhance the accuracy of, the estimated breeding value. During this trial period, the cow's progeny is put 'on hold'. A poor performance means that both the potential sire mother and her progeny are dropped; good scores transform the potential sire mother into a proven sire mother with progeny already available for use in the breeding programme.

Cloning and sexing are still being perfected by scientists, although the first commercial applications have already produced results; for example the successful Blackstar clone, Blackstar II and the sale of small clones at auctions in the US (Veeteelt, 2000b; 2001d). At this point in time, sexed semen is commercially available only in the US and the UK. Time will tell what impact these techniques will have on breeding. Clones might be used to provide 'tried and tested' genotypes on a large scale. A specific evaluation of additive and dominance effects could lead to more intensive use of clones. Clones from a breeding programme will probably not be directly applicable in commercial dairy production. Rather, animals for production will be the result of a functional cross (Groen, 2001). The value of a technique such as sexing is also related to optimising the use of breeding programme results in commercial dairy production.

2.5.3. Indexes and genetic trends

Before the use of chemical fertiliser became ingrained, the characteristics of the diverse cattle breeds in were connected with the soil type of the regions where they originated. In the Dutch provinces Drenthe and Noord-Brabant, two provinces with sandy soils, lived the so-called sandy soil cow. Like heathland sheep breeds, these cows were well adapted to ecosystems on poor soils. With chemical fertiliser, however, farmers on sandy soils were able to boost the protein content of their crops. The sandy soil cows were therefore crossed with breeds with stronger dairy traits: black and white Fries Hollands (FH) type and red-and-white Maas-Rijn-IJssel (MRIJ) type cattle (Baars, 1993). The marketing of milk improved, too. The butter and cheese cooperatives that first arose at the end of the 19th century increased the market for milk and made it commercially viable for farmers to specialise in dairy production.

Until 1970, Dutch breeds predominated on Dutch dairy farms. The most popular breeds were FH and MRIJ, with smaller populations of Groningen Blaarkop, Friesian Red-and-White, Dutch Belted and Witrik. The average milk yield per lactation was low. These were basically dual-purpose breeds, which meant that selection on milk production was not intense. This became painfully apparent when countries with much harsher conditions, achieved a higher mean production per cow than the Netherlands. Before 1970, in fact, Dutch milk production in fact lagged behind that of many countries. Influential breeders had laid too much emphasis on conformation, dual purpose and aspects such as colour and marking of the skin. They were also responsible for the shorter stature of the Friesian-Holland breed, which eventually were only 125 to 130 cm tall.

It was Professor Rommert Politiek in the early seventies who urged Dutch breeders to select on objective production traits and to work together to achieve a rapid improvement in milk production. His slogan for this type of breeding was "cross the best with the best as quick as possible". The breeding goal was "cattle that can produce milk and meat in the most economic manner in current and future conditions on the farm and on the market" (Politiek, 1979). It was in this period that the young-bull system was developed, and the quantitative estimation of breeding values were introduced and further developed to enable the objective comparative assessment of breeding animals (see also section 2.4).

However, the national dairy herd was still under-achieving. The so-called Poland test again made clear that the milk production of Dutch cows still lagged behind that of the rest of the world (Jasiorowski et al., 1988). In 1972, therefore, Holstein Friesian bulls were imported, first from Germany and later from the United States (Strikwerda, 1998). By 1978, the average milk yield in the Netherlands had risen to 5317 kg milk in 310 days at an age of 4.5 years. In comparison, mean production in the US in 1976 was 6954 kg milk.

These results gave a boost to AI organisations, as all farmers wanted to benefit from the genetic improvement in milk production. In the 1980s nearly the entire black-and-white population in the Netherlands and its neighbouring countries was displaced by the Holstein breed through AI.

The introduction of Holsteins is not the only reason that milk production per cow has risen rapidly in the Netherlands from the 1970s on. Improvements in housing and fodder production have also played an important role (Strikwerda, 1998). The introduction of Holstein Friesian blood improved the herd's genetic disposition for milk production. Between 1970 and 1990, mean production per cow increased by 57% to 8123 kg milk per lactation.

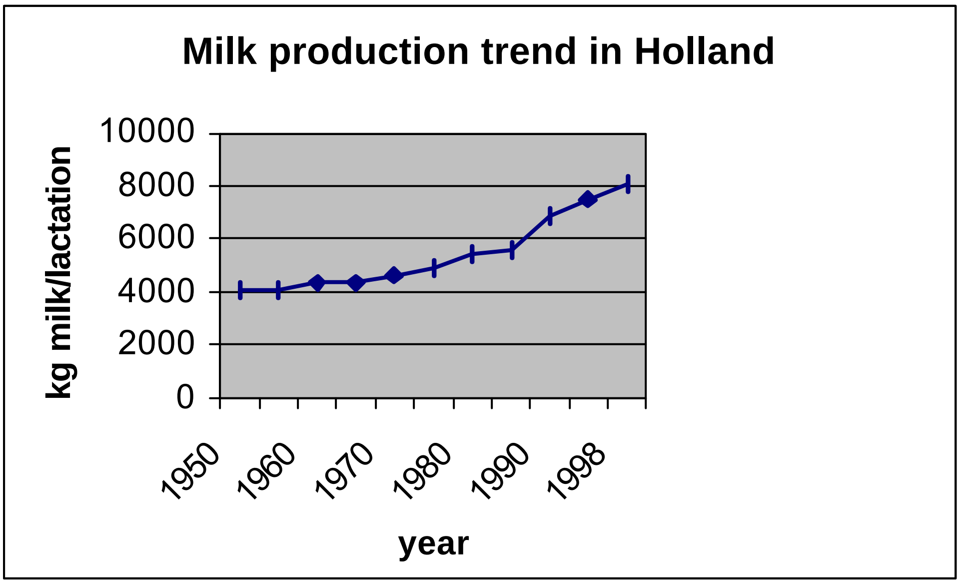


Figure 2.1: The development of mean milk production per lactation per cow in the Netherlands, from 1950 to 1998 (source NRS).

Mean production per cow also increased for the local breeds which survived the Holstein invasion. Many pure bred FH cows of the FH breeding society produce nowadays over 7000 kg milk.

By the early 1990s, the breeding organisation Holland Genetics felt that the genetic merit of the Dutch Holstein population equalled or even surpassed that of the American, Canadian and German populations. Selective breeding began to take place within the Dutch Holstein population. Breeding technologies were perfected and the selection system was adapted to the Animal Model (see section 2.4). Next to AI, embryo transfer was utilised to speed up the propagation of animals along the mother line. Fewer foreign bulls were marketed, and those that were available did not only originate from North America but from European countries such as Italy and France as well. Next to Holsteins, breeders also imported other breeds such as Jerseys (Denmark and US), Brown Swiss (Germany and US) and Montbéliarde (France). After twenty years, the Dutch production index Inet is slowly starting to lose its dominant role in breeding. There is growing criticism of the narrow focus on production in the selection process. The productive lifespan of cows has declined and there are indications that fertility has diminished, too (Buckley et al., 2000). The last decade several breeding companies world wide are developing new indexes including durability traits as fertility and health traits. In the Netherlands Holland Genetics, Wageningen University and the Royal Dutch Herdbook Organisation collaborated to developed the durable performance sum (DPS) index, which is a combination of the milk performance index Inet and a sum index for durability traits (DU) (Vollema, 1999; Veeteelt, 2000a). The newest index in the making is for body weight, based on conformation data. Fitness and health traits will then have a weight of 43% in the total DPS index (Veeteelt, 2001b).

2.5.4. Organic dairy breeding today in the Netherlands

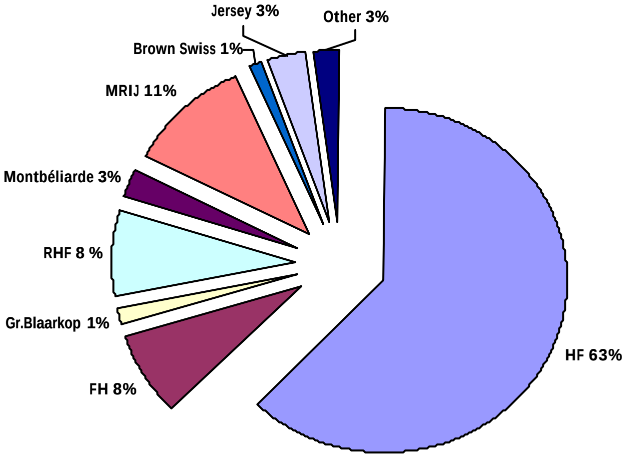
In 1998, Louis Bolk Institute conducted a survey on organic breeding practices among the entire population of organic and biodynamic dairy farmers in the Netherlands. The response was 50%. Apparently, breeding is close to many dairy farmers' hearts and concern. Most respondents had converted to organic production fairly recently. On average, they had farmed organically for three years at the time of the survey. The typical farm of this group of respondents is expressed in key indicator means in table 2.2. The average number of livestock units per hectare, a measure of livestock density, was 1.53.

Key indicators:	Average:
Number of milking cows	49,1
Number young stock	34,1
area (ha)	39,5
LSU / ha	1,53
Milkquota	3,28
Kgmilk / ha	8300
Kg milk	6902
% fat	4,37
% protein	3,47

Tabel 2.2: Means for key indicators of respondents' organic farms, 1998.

On the organic farms surveyed, cows had about 71% Holstein blood (HF + RHF) in 1998 (see figure 2.2). Eleven and eight per cent of this organic herd had MRIJ or FH blood, respectively. Only a handful of farms had pure MRIJ or FH herds (2%) while 20% of farms had pure Holstein herds.

Fig. 2.2: Blood lines in the Dutch organic dairy herd in 1998



The survey revealed that more and more organic farmers prefer to use other breeds than Holstein. Crosses with foreign breeds such as Montbéliarde and Brown Swiss are relatively common. The proportion of FH farmers, however, is declining. FH blood is found on only 44% of organic farms, and only 2% of organic dairy farmers still actively breed FH (Elbers, 2000).

Fifty-seven per cent of these organic farmers never have their cows served naturally. Natural serving tends to be used more often on heifers. Sixty-five per cent exclusively used AI to fertilise their dairy cows. This is shown in table 2.3. Purchel (2000) showed that natural serving is responsible for only 2.7% of inseminations on organic farms, although natural serving is likely to be underreported.

	% young stock	% milking cows
AI	57	65
Nat. Servings	19	8
Combination	24	27

Table 2.3: Use of natural serving and AI on organic dairy farms in 1998

Dutch organic farmers choice of bulls differs little from the top ten of bulls used by their conventional counterparts. The greatest overlap is found for farms with pure Holstein herds. However, bulls with a slightly lower Inet but higher DU -- for example, Archibald and Delta Lava -- are slightly more popular among organic farmers compared to their nationwide use rating. In table 2.4, we list the most commonly used Holstein bulls on the surveyed farms as well as the nationwide top ten in the AI year 1998-1999.

Organic 1998			National (conventional) 1998-1999		
AI bull	Inet	DU	AI bull	Inet	DU
Cash	465	111	Cash	465	111
Archibald	320	106	Lord Lily	372	105
Boudewijn	566	100	Tornado	439	98
Tornedo	439	98	Boudewijn	566	100
Lord Lily	372	105	Arrow	425	103
Lava BL	344	114	Ronald	439	106
Apollo	521	99	Royal	476	102
Ronald	439	106	Archibald	320	106
Royal	479	102	Daylight	361	104
Spirando	356	108	Lava BL	344	114
Average:	430	105		420	105

Table 2.4 Use of Holstein bulls by organic farmers in 1998 compared to nationwide use (conventional and organic) in 1998-1999. Inet =milk production performance index, DU = durability index.

Among organic farmers, the most popular foreign bulls in 1998 were Genereux (Montbéliarde), Etazon Energy (Brown Swiss) and Midnight Storm (Jersey). Besides the ten most popular bulls (based on number of inseminations), organic farmers used another 160 bulls of different breeds and bloodlines.

It was most interesting to note that 41% of respondents was not satisfied with the current selection of bulls on offer. One fourth of these farmers were uncertain about which type of cow would be most appropriate for their organic farm system. Sixteen per cent of these farmers felt that there was not enough choice within the selections of alternative breeds. Eight per cent of Holstein breeders thought that there was not enough new blood in the current selection, i.e. they are concerned about inbreeding and biodiversity. Thirteen per cent of respondents would like to see bulls with stronger muscularity traits on the bull charts. Organic farmers would also like an index for roughage intake efficiency and information about whether the bulls are ET-free or IVF-free in their bloodlines. Only 12% of organic farmers in this survey used the aAa system. The other 88% never used this system and in fact had in most cases never even heard of it.

In summary, our survey showed that very few farmers carried out breeding on their own farms. Earlier, we wrote that respondents to the survey were typically fairly recent converters. On-farm breeding is more common on long-standing farms, especially bio-dynamic farms. The survey also showed that the large group of recently converted organic farmers generally used the same bulls as their conventional colleagues, although they did have a clear tendency to try out different bulls witness the high number of bulls used by these farmers in a single year.

2.6. Alternative breeding strategies

In the Netherlands, CR-Delta, Holland Genetics and NRS have joined forces and acquired a dominant position in cattle breeding. Most Dutch dairy farmers are members of this national breeding and AI conglomerate. Breeding strategies and the methods of estimating breeding values have been developed by these organisations. In the Netherlands and elsewhere, however, alternative breeding strategies do exist. We describe a number of these in this section.

2.6.1. Breeding based on lifetime production

Many farmers have continued to select animals on the basis of parent animals' realised production as well as EBVs. When the EBV for milk production was first introduced, a statistically reliable prediction of future production was based on information about the first three lactations. Now, however, the Animal Model generates EBVs using only first lactation data of daughters and other relatives. Some groups of farmers and breeding organisations, however, still attribute a high value to the realised productions of a bull's ancestors and use this data in their own breeding programmes. Two streams working along these lines can be distinguished: (1) lifetime production and line breeding according to Professor Bakels; and (2) lifetime production breeding according to the Ecological Sum Index (Ökologischen Gesamtzuchtwert, ÖGZ).

Ad 1. Line breeding according to Professor Bakels' approach

Professor Frederik Bakels is Germany's Holstein pioneer. In 1958 he started a line breeding programme on the basis of vitality, vigour and lifetime production. This last aspect was his main breeding goal. Bakels' breeding strategy respected the principle of "the natural laws of the animal". By their nature, cows roam long distances. They are also mammals and ruminants. Bakels took the physiological aspects of these characteristics into account in his breeding programme. A mammal's milk production can be classed on the third tier of the physiological hierarchy, as milk increases the progeny's chances of survival. It is therefore easy to select animals on this trait, and to use it wrongfully from the perspective of the animal. According to Bakels, breeders must first identify a cow which has achieved a high lifetime production in relation to energy uptake and then find out how she did it, i.e. what her constitution was and learn from that (Postler, 1989).

Before setting up his own breeding programme, Bakels studied the line breeding techniques used by traditional breeders. In his own breeding programme, he carried out rotation crosses with three different American Holstein-Friesian cow families. These cow families differed in musculature, type and maturation rate. Following this strategy, he became the first breeder in Germany to achieve a mean production of 6000 kg of milk in a herd of 90 cows (Postler, 1989).

The line breeding programme was expanded to a working group of about 100 farmers carrying out lifetime production breeding. The production and longevity of cows on these farms was monitored. It soon became apparent that animals from this breeding programme produced about 516 kg more milk per year and lived one year longer, on average, than other black-and-white dairy cows in Germany (Postler, 1989).

By request of the Dutch federation of biodynamic farmers and Louis Bolk Institute, Professor Bakels visited the Netherlands in 1989 to explain this breeding strategy. It was adopted shortly thereafter by a handful of farms. Unfortunately, their efforts did not survive, in part due to the failure to establish a sufficiently large working group of breeders in the Netherlands as well as probably the physical distance from Bakels' established working group in Germany. In Germany, however, the working groups still thrive.

Ad 2. *Lebenslinien* working groups

Two breeding groups in Germany (Arbeidsgemeinschaft für Rinderzucht auf lebensleistug; Arbeidsgemeinschaft Lebenslinien) one in Austria (Arbeidsgemeinschaft Österreichischer Lebensleistungszuchter) and one in Switzerland (Verein zur Erhaltung und Förderung des alten Schwartzbunten Niederungsrindes e.V.) together with lifetime production breeders in the Netherlands make up a breeding programme based on lifetime production. A list of inclusion criteria has been drawn up for breeding bulls (see box on lifetime production breeding). First and foremost, bulls are selected on the basis of the lifetime production of their mothers and grandmothers (mother's mother, MM, and father's mother, FM). Their joint lifetime production must be at least 150,000 kg milk. The other criteria largely agree with components of the ÖGZ index (see ad 3).

Lifetime production breeding; criteria for breeding bulls

bull's mother (M) + mothers-mother(MM) + fathers-mother(FM) produced 150,000 kg milk
milk production index > 106
breeding value for productive life span mothers-father (MF) > population average
persistence M and MF > population average
kg milk per lactation of M increases during first three lactations
parturition and live-born calves > population average
breeding value for milk cell count between 90 and 120
conformation: no deformities in pelvis, claws, udder depth, udder attachment, hind quarter

Ad 3. The Ecological Sum Index (ÖGZ)

Guntler Postler is the driving force behind the Ökologischen Gesamtzuchtwert (ÖGZ) which is based on line breeding and *Lebenslinien*. The ÖGZ is a sum index of traits which are considered important for organic farm systems. The traits which compose the index are listed in Apendix IV. The index is calculated for bulls from conventional breeding organisations in the participating countries.

In the ÖGZ estimation of breeding value, only the data of bull daughters that have successfully completed at least three lactations is included. Compared to first lactation indexes, it takes longer before a bull's rating on the index is made available. The second and third lactations weigh more heavily in the ÖGZ, so that the index prevents selection on first lactations and thus on early-maturing animals. The ÖGZ also sets greater store by persistence and a steady increase in production in the first three lactations. The makers of the index do not want to select on high productions at an early age, because it stunts the animals' development and growth. Animals which mature more slowly must be given the chance to demonstrate continued growth after the first lactation. A value for longevity is also based on parents' data. Functional traits are ease of parturition, vitality, legs and udder.

2.6.2. Kin breeding and foundation breeding

In this section, we explain the strategies of kin breeding and foundation breeding as practised by the Dutch Friesian breeding organisation. A foundation breeding system was set up by this organisation in order to preserve the FH breed in the Netherlands. In foundation breeding, a handful of breeding farms form the basis, or foundation, of the national population. Each farm carries out its own kin breeding programme using its own bulls. Dirk Endendijk, a prominent foundation and elite breeder of the FH organisation, gives us a good example of what kin breeding is about (Baars, 1990b; Baars, 2001 in prep.). A more general description is given in the box, below.

In kin breeding, to some extent, related animals are mated to reduce the variability within a family by a low degree if inbreeding. The animals become after years more homozygous, and approach the ideal type for the farmer and the specific farm conditions.

Different degrees of inbreeding are possible (Anema, 1950); it is up to the breeder to determine the degree of inbreeding necessary for his strategy. For example, over a period of 25 years, Endendijk has achieved a purebred herd while avoiding matings between close relations as much as possible. He was therefore able to produce a breeding bull, Rivelino 279, which has only a moderate degree of inbreeding (appendix III).

The advantage of inbreeding is the homozygosity, which enables the breeder to predict with greater accuracy which traits will be passed on by a bull and which combinations suit his breeding goal. After all, a more homozygous animal transmits its own genes with less variation to its offspring. This makes up for the disadvantages of breeding with only a small population. Step by step, trait by trait, a kin breeder can generate and consolidate genetic improvements. Once the breeder has achieved his goal up to a certain level, his aim must be to maintain and consolidate that level.

Start-up and structure of farm-specific breeding (Endendijk, 2000)

User phase
- Preferably, start with a herd with longstanding cow families and keep the family names;
- mate all cows with one or two bulls from a 'elite' breeding farm that appeals to you and which are kept in conditions which largely match those on your own farm;
- mate the offspring with related bulls from the same breeding farm in order to obtain 'double blood'.

Transition to own farm-specific breeding
- Select the first few own bulls from a handful of best cows (cows that you would keep even if it meant losing all your other cows; i.e. cows that appeal most to you) and mate this bulls as a yearling with a limited number of cows (max. 10% of the herd);
- continue to use bulls from the same breeding farm as earlier;
- if necessary, buy new cow families.

Own farm-specific breeding
- Gradually increase selection of own bulls to an average of 1 bull per 10 cows per year; ensure a good sampling of bulls from the different cow families;
- mate each bull with females outside of his own family;
- try to use each bull equally (same number of matings);
- avoid mating close relations as much as possible;
- introduce fresh blood by buying a desirable cow which is then mated with an own bull. The cow can prove its worth on your own farm. Female offspring is again mated with a related own bull. Male offspring from this match has 'double blood' and is used for breeding.
- In the male line, fresh blood is only introduced by a double-blooded bull produced by one of your own bulls.

In order to select animals in an on-farm breeding programme, it is necessary to keep youngstock for a longer period of time. After all, many characteristics are not clearly expressed until adulthood. Some kin breeders do not select their heifers until after their first calving and milkings. Bulls, too, cannot be evaluated until they are older. Through years of experience, however, breeders become more adept at identifying promising calves at an early age and thus need to rely less heavily on the realised performance of mature animals.

Breeding goals and farm conditions are unique for each farm, so that on-farm kin breeding provides diversity within the breed, which is essential for future generations, develops between farms. Should important traits be lost on one farm, they can be recovered by the breeder by bringing in animals from other foundation farms. The variability within a breed also serves the 'users' of this breeding system. Users can use bulls from different foundation farms, for example in a system of rotation crossing, to make the most of the heterosis effect within the breed. Sometimes bulls from only one farm are sourced in order to obtain an identical population.

A typical example of the diversity within the FH breed in the Netherlands is the simultaneous occurrence of the more traditional, classical Friesian type (flat and round) and the longer, slightly taller Noord-Holland type. Animals from different breeding farms also differ in milk production, marking, colour and so on.

2.6.3. The choice for another breed

A farmer might also elect to introduce another breed into his herd to raise production efficiency. HF is still the most popular breed in the Netherlands, but organic farmers also use other breeds, mostly foreign breeds such as Jersey, Montbéliarde and Brown Swiss. Only small populations of traditional Dutch breeds like FH, MRIJ, Blaarkop, Lakenvelder, Witrik and Friesian Red remain.

Little research has been carried out into differences between breeds because of the high cost of such research. Oldenbroek et al. (1988) carried out a study of 159 heifers and 72 third-calving cows on roughage-only rations. The most important results of this study are listed in table 2.5. According to this study, the differences within a breed are greater than the differences between breeds. In other words, besides choosing a new breed, farmers would also do well to select for food uptake capacity in their original herd.

Breed	Jersey		HF		FH		MRIJ	
Lactation	1st	3rd	1st	3rd	1st	3rd	1st	3rd
DM uptake (kg)	2739	4152	3548	5087	3484	4990	3344	4666
max. DM / day	10.0	15.2	13.0	18.6	12.8	18.3	12.2	17.1
kg FPCM	3494	5631	4173	6468	3709	5604	3578	5420
body weight (kg)	324	402	481	613	481	601	501	655
maintainance	957	1287	1384	1780	1568	2146	1538	1960
left for milk prod.	1782	2865	2164	3307	1916	2844	1806	2706
% of food uptake used in milk prod.	65	69	61	65	55	57	54	58

Table 2.5 Food uptake capacity and milk production for different breeds (Oldenbroek, 1988)

More recently, studies have been conducted in Ireland and Scotland on the differences between breeds in performance and fertility in relation to the amount of concentrate feed in rations (Buckley et al., 2000). Unfortunately, inherent differences within breeds were not in this study, so that a real comparison between breeds of performance on a low-concentrate diet could not be made.

Breeds at organic farms in the Netherlands

Dutch Friesian

Use: dual-purpose type (dairy and beef)

In the old days, Dutch Friesian cows dominated the Dutch rural landscape. Animals of this breed are generally shorter (1.35 m) and stockier than the HF population which stems from them. The economic return of culled cows and calves is considerably higher for FH herds, however. Most FH cows in the Netherlands are black-and-white; the red-and-white population here is very small. Most black-and-white FH cows are predominantly black, with a white band behind the shoulder and in front of the pelvis.

Breeders clearly aim for a durable, dual-purpose dairy-beef animal. The breeding goal of the FH herd in the Netherlands is: a well-developed, generously built, robust and sufficiently muscled cow which is capable of producing large yields of milk with good fat and protein contents for many lactations (Frahm, 1985). Most FH breeders in the Netherlands practise either line breeding or kin breeding (see section 2.6.2). The FH population in the Netherlands is declining. The Dutch Friesian Herdbook Society was established by a small group of breeders in 1983 in order to save the traditional Friesian breed from extinction. In 1990, the herdbook recorded only about 1500 animals.

Maas-Rhine-IJssel (MRIJ)

Use: dual-purpose (dairy and beef)

The Maas-Rhine-IJssel breed (MRIJ) owes its name to the rivers which flanked the low-lying farmland where the breed was developed. For many years, breeders of these fairly small red-and-white cattle selected strongly on both milk yield and musculature, producing a truly dual-purpose animal. Since 1970, many MRIJ breeders have introduced Red Holstein blood to improve dairy traits. In 1987, the use of purebred MRIJ bulls had declined to 16%. In 1993 this had dropped even further to 8.6%. This trend continues to the present day (Felius, 1998).

Groningen Blaarkop

Use: dual-purpose (dairy and beef)

Groningen Blaarkop is a dual-purpose breed of red or black animals with white heads and black or red blazes around the eyes. This type of marking is very old and found in many breeds, including Hereford. In general, the udder is slightly less pronounced compared to black-and-white cattle. Initially, Blaarkop breeders were focused on beef production rather than dairy. Around 1930, the animal transformed from a beef-dairy type to a dairy-beef type. At the end of the 1970s, this trend towards milk production received an additional boost from experimental crosses with Holstein, which were prompted by the need to introduce fresh blood to the population. By 1988, only a quarter of the population was pure Groningen Blaarkop. The hybrid animals did however retain the characteristic blazes around the eyes. In 1986, four breeders established the Groningen Blaarkop Syndicate with the aim or retaining the traditional dual-purpose type and the characteristic colour and marking of the breed. In 1990, there were only 15 breeding bulls, 12,000 purebred cows and 450 registered heifers of this breed, primarily in the provinces of Groningen, Zuid-Holland and Utrecht. This qualifies the Groningen Blaarkop as a rare and endangered livestock breed.

Montbéliarde

Use: dual-purpose (dairy and beef)

These red-and-white cattle with their characteristic white heads originate from eastern France. In 1990, 11% of the French national herd was Montbéliarde; it ranked second in the list of dairy breeds. The breed was first introduced in the Netherlands about ten years ago. Montbéliarde cattle are heavily built, with good musculature, strong legs, high milk yield and efficient roughage conversion. The cows have well-attached, large udders which clearly mark them as dairy types. There is a difference however, between plains Montbéliarde and highland animals. A high-concentrate diet plays a larger role in selection of the former, while the selection of highland Montbéliarde is based more on roughage rations.

Brown Swiss

Use: dual-purpose (dairy and beef)

The history of the Brown Swiss breed bears a strong resemblance to that of the Holstein Friesian breed. Both breeds were originally European breeds exported to the United States more than one hundred years ago. There, the animals were bred for dairy production and have now become a major genetic source for European breeders. Just as Dutch FH cattle are the ancestors of today's Holsteins, Swiss Braunvieh are at the roots of the Brown Swiss breed. In general, Brown Swiss cattle are larger and have a better build than the European Braunvieh. They have a superior udder and better positioning of the teats. Their claws and legs are excellent, traits inherited from their alpine ancestors. Purebred Brown Swiss are uniformly yellow in colour, with variations from light yellow to red-brown. Crossing Brown Swiss with black-and-white cows produces animals which are either uniformly black or brown. Crosses with red-and-white give uniformly brown or black cows as well as black-and-white or red-and-white animals.

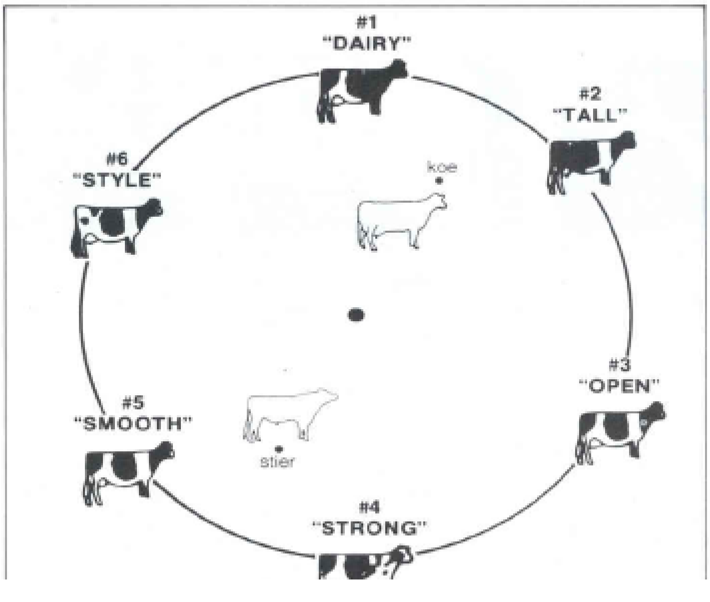
Jersey
Use: dairy
Jersey cattle originate from the Channel island Jersey, but have long since spread to all corners of the earth. Jerseys have always been bred for dairy production. The animals are renowned for producing milk which is rich in butterfat and protein, and for their characteristic bay colour. However, Jerseys can also be yellow, brown or grey and all these shades can vary from very light to very dark. Some animals do have white spots, but uniformly coloured animals are preferred. The front end and tail are usually dark, while the belly and inner legs are a lighter shade. Many cattle are eelbacked. The claws and horns are darker than the hide.

Holstein Friesian
Use: dairy
In the 1960s, many farmers wished to improve their herd by introducing new blood. The Friesian-Holland cattle which were most common in the Netherlands at that time were crossed with high yielding Holstein crosses from the US and Canada. These crosses were direct descendants of the Friesian-Holland black-and-white animals. The crosses realised a rapid transformation of the dual-purpose FH cattle into real dairy types. By 1990, the bloodline of most herdbook heifers was three parts Holstein. In that year, there were 1,680,000 Holstein cows, of which 51% were registered in the herdbook. Holstein-Friesians can be either black-and-white or red-and-white. These cattle have a typical dairy build; they are usually quite large (1.45 m) and have good udders.

2.6.4. The triple-A system

The aAa or Triple A system was developed in the US by Bill Weeks. Triple A is an acronym for Animal Analysis Associates. The system evaluates the strong and weak points in a cow's physique. It is meant as an alternative to the conformation assessment, and its ideal is a harmoniously built cow. The Triple A system is based on six descriptions of type (see figure 2.4).

Figure2.4:The descriptions of type in the Triple A system. (Source: Bill Weeks)
Code 1 coincides with the Jersey type, code 5 represents the barrelled FH cow, a type of cow that was common in the Netherlands before the mass introduction of Holsteins



The number sequence in a bull's attributed code indicates the trait with the highest heritability to the bull's daughters to the least heritable trait. Cows are coded in the exact opposite manner. A cow's code can be placed next to different bulls' codes. The bull whose code best matches the cow's code would best make up for the cow's shortcomings and is thus the best mate. The goal of the Triple A system is to achieve a balanced match, and to breed cows which are most profitable for farmers. Profit is broadly defined here and includes health, fertility and longevity in addition to yield. In the Netherlands, about 1000 farms use this American mating system. Only 25 analysts worldwide are qualified to assess and code cows and bulls according to this system.

2.7. Developments in poultry breeding

2.7.1. Breeding and genetic trends in the 20th century

In Europe, the breeding of laying hens did not start to take off until the early 20th century. In those days, a free ranging hen produced about 60 eggs per year. There were about one million hens in the Netherlands, all living in small flocks. The breeding of laying hens became lucrative when the demand for eggs rose due to the egg trade. Incubators for hatching were introduced for propagation. Demand for eggs grew even more after World War I and special hen houses were constructed next to a fenced run where the hens could scratch. Production rose steadily to an average of 210 eggs per hen per year. In 1930, there were 25 million layers in the Netherlands. Popular breeds in those days were Barnevelder and Welsumer. After WW II, poultry housing gradually moved away from hen houses to large sheds. Poultry farms expanded in size and by 1950, 31 million hens were kept on 4000 farms. On average, this came down to about 7750 hens per farm. The demand for eggs continued to grow and Dutch production breeds gradually made way for American breeds such as New Hampshire and Rhode Island Red.

Until the late 1950s, poultry was always bred for two purposes: laying and meat. Cockerels were kept for the slaughter. Laying hens were slaughtered after their laying period. In order to obtain fleshier animals, In the Netherlands, hens were crossed with broiler breeds, such as Noord-Holland Blue.

After 1960, the production of eggs and meat was split up and two specialised sectors developed. White Plymouth Rock and Cornish were popular broiler breeds. The former also had fairly good egg laying qualities which was useful for propagation. These two breeds still form the foundation of modern broiler hybrids in the world. In 1960, the Netherlands had 15 million broilers. Today, there are 50 million.

Breeding for the laying sector was taken over by specialised multinational companies. The genetic improvement of production lines was largely realised through selection within these lines and by crosses between purebreds from these lines, which utilised the benefits of heterosis. Part of the population's genetic improvement in laying must be attributed to the introduction of laying batteries. In batteries, hens were housed in small groups in cages, and this changed the level at which selection took place, from the flock to individual animals. These animals were further adapted to the battery system and so that they now achieve an average production of 310 eggs per hen per laying period (Albers, 2001). This progression in egg production is depicted in figure 2.5.

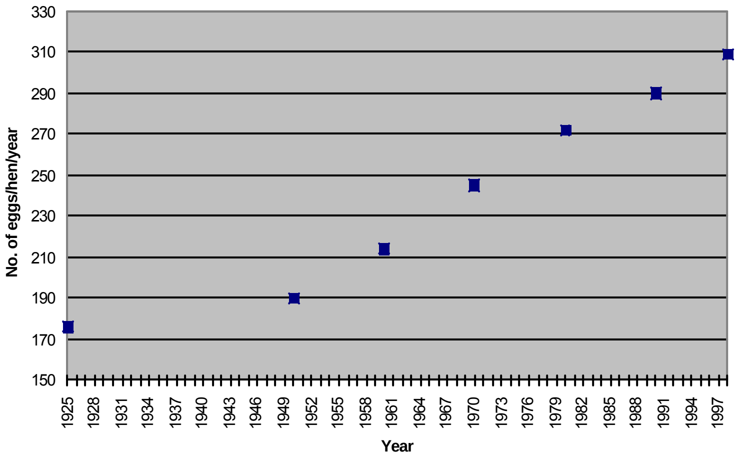


Figure 2.5: The trend in egg production, from 1925 to 1997 (Albers, 2001)

Currently, only seven multinational companies breed laying hens. These hens all achieve similar production levels. Competition between breeding companies is fierce and profit margins are low. This is probably the main reason for the lack of genetic variability between the lines of the different companies. It is likely that, despite the air of mystery and confidentiality that surrounds their work, the companies have ‘borrowed’ from each other in the past, because their pure lines be almost identical (Hunton, 1998).

Under European law, laying batteries are to be phased out because they compromise the hens' welfare. The deadline laid down by the Dutch government is 2012.

An important consequence of the differentiation between egg and meat production is that cockerels from laying hatcheries are useless and therefore killed after hatching. Debeaking has become standard practice in the laying sector, to prevent hens from feather pecking and kannibalism. In the long run, however, this practice will be banned by European law. Debeaking is not allowed in the organic laying sector, but problems with feather-pecking and cannibalism are very common (Hierden, 1997; Bestman, 2001). Organic regulations also prescribe that hens must have access to an outdoor run. This does mean that they run a higher risk of becoming infected with worms, Newcastle disease, coccidiosis and pathogenic bacteria (salmonella, campylobacter).

Similar developments have taken place in the broiler sector. Breeding has become the domain of a handful of breeding companies which improve their pure lines and sell hybrids for commercial use. While laying hens must be light and fertile, broilers should be fleshy and large. This raises problems at the propagation stage, for the mother animals tend to be too heavy, which greatly reduces their fertility, and are therefore put on a strict diet. The mother animals lay about 70 eggs per year. Breeders have greatly accelerated the growth rate of broilers, which now reach the slaughter weight of 1.5 kg in a mere 40 days. By comparison, in 1950, it took broilers 12 weeks to acquire a body mass of 2 kg. Broilers are housed on the ground in large groups of tens of thousands of animals.

2.7.2. Organic poultry production and breeds used in the Netherlands

Dutch organic laying farms select animals from the modest pool of hybrids or brands provided by commercial breeding companies. Popular brands at the moment are Bovans Nera and Goldline. New, rising brands are Lohman Silver and Hybro Amber. Laying poultry farmers tend to stock up with the best available hen at the moment, which results in pretty much identical flocks.

In organic conditions, these brands have a lower production level than on conventional farms. On average, organic flocks achieve a production level of about 85%, compared to 95% or more in conventionally kept flocks (Van Sambeek; oral information). Feather-pecking and cannibalism are persistent on many organic farms (Bestman, 2001; Hierden, 2000). Mortality rates on organic farms can be as high as 15%, compared to 5% in conventional units (Sorensen, 2001). In smaller flocks the prevalence of feather-pecking and cannibalism differs between brands, but in larger groups (more than 1000 hens) these problems occur regardless of brand.

Many farmers adapt their housing systems in order to prevent problems as much as possible. Until now, breeding companies have not set up a distinct organic breeding programme because the global market for organic layers is too small. Worldwide, demand for these systems is growing – among conventional as well as organic farmers – and promises to be a lucrative market for breeders. Organic agriculture might profit to some extent from this development, as many aspects of free range systems overlap with organic systems.

Outside the Netherlands, particularly in Germany, alternative hybrids are available such as Lohman Tradition and Tetra Zweinutz. The latter is a product of Hendrix Poultry Breeders BV, a Dutch daughter of Nutreco. Tetra Zweinutz are dual-purpose hens which are used in Germany because there is a market there for finished layers, unlike in the Netherlands. This dual-purpose breed could have benefits for organic agriculture, which has principle objections to the killing of laying cockerels immediately after hatching. Dual-purpose cockerels are not waste products: on the contrary they are fattened and sold as broilers.

Hendrix also supplies hens to the US which are not disposed of as soon as they start to moult, and they produce eggs for several laying seasons. These brands might be interesting for organic laying units, not only because of the high price of new layers (Deerberg, 2001) but also because it is more in keeping with organic principles.

Currently, the organic broiler sector in the Netherlands is made up by only a very few businesses. About 5000 broilers a week are slaughtered by two slaughterhouses in Uden and Lelystad. The largest broiler farm houses about 12,000 broilers. A hybrid supplied by Hubard ISA in France is most popularly used. It is a cross between a fleshy laying hen, JA 57, and an ISA88 rooster. These poultry animals have only recently been bought by a Dutch propagator who is going to produce them for the Dutch market. Unlike conventional broilers, which are ready for slaughter 6 weeks after hatching, these organic broilers are fattened for 81 days. The hybrid JA857 can cope well with this longer fattening period. In Germany, Hubard ISA broilers are also kept. On average, these birds grow to 2 kg in eight weeks.

2.8. Developments in pig breeding

2.8.1. Breeding and genetic trends in the 20th century

Pigs have traditionally been kept to process waste into high-quality food. This changed at the beginning of the 20th century. The invention of synthetic chemical fertiliser boosted crop production and made it possible for farmers to feed cheap, high-quality fodder to their pigs. Their role as waste processors diminished as their primary function became meat production. The government encouraged the establishment of pig herdbooks, and the central testing of animals for breeding (Merks, 2001; Gron Pedersen, 1997). Selection indexes were developed so that animals could be selected on growth rate, food conversion and backfat thickness. Selective breeding did not extend beyond existing breeds (Merks, 2001). Until 1960, about 70% of the Dutch pig population were Dutch landrace pigs (NL); the remaining 30%were of the Great Yorkshire breed (GY).

Crosses became more prevalent after 1950, in tune with developments in plant and poultry breeding (Dickerson, 1952, 1973). In the 1960s breeders started to apply the technique of father and mother lines, as propagated by Smith (1964) and Moav (1966). Within breeds, different lines were formed with growth traits being carried by the father line and reproduction traits by the mother lines. This enabled a more accurate selection of desirable traits and greatly improved breeds' genetic merit for the various traits. The genetic improvement between 1930 and 1990 is depicted in table 2.6. Backfat thickness almost halved during this period, while growth increased by 340 g per day. Feed conversion also became considerably more efficient.

breed	year	Daily gain (g)	feed conversion (kg / kg)	backfat (mm)
NL	1930	500	3.5	45
	1947	650	3.4	33
	1972	788	2.6	26
	1990	840	2.8	24
GY	1930	550	3.4	48
	1947	680	3.2	35
	1972	815	2.5	27
	1990	840	2.7	22

Table 2.6 Progress in growth, feed conversion and backfat thickness of GY and NL pigs in the Netherlands between 1930 and 1990 (Merks, 2001)

Dividing up traits between father and mother lines brought more benefits especially with respect to litter size. In the 1980s, family selection was introduced in the mother line so that breeders could select more efficiently on litter size (Haley et al., 1989). This resulted in a average litter size of 12.3 piglets in the GY motherline in 1991, an increase of one piglet over a period of twenty years (see figure 2.6).

In the last ten years the BLUP (best linear unbiased prediction) model has become a standard selection instrument in pig breeding. Selection on litter size using BLUP resulted in a second boost of 0.5 piglet per litter over a period of five years (see figure 2.6). Production traits such as backfat thickness could be improved on faster in the father line using the BLUP method. In recent years, breeders have broadened their aims from production and fertility to also include characteristics pertaining to meat quality and piglets' vitality. Molecular selection methods (Rothschild, 1998; Fuji et al., 1991) enable a rapid selection on, for example, receptiveness to halothane (a stress reaction). Other applications of marker technology are in development. such as tests for resistance to disease and meat quality (Visscher and Haley, 1998).

Selective breeding is still restricted to selection within breeds because data can only be recorded accurately on breeding farms. Individual pig farmers do not record production data like in dairy farming. The national registration rules also impede the collection of data on individual pigs (Merks, oral communication, 2001).

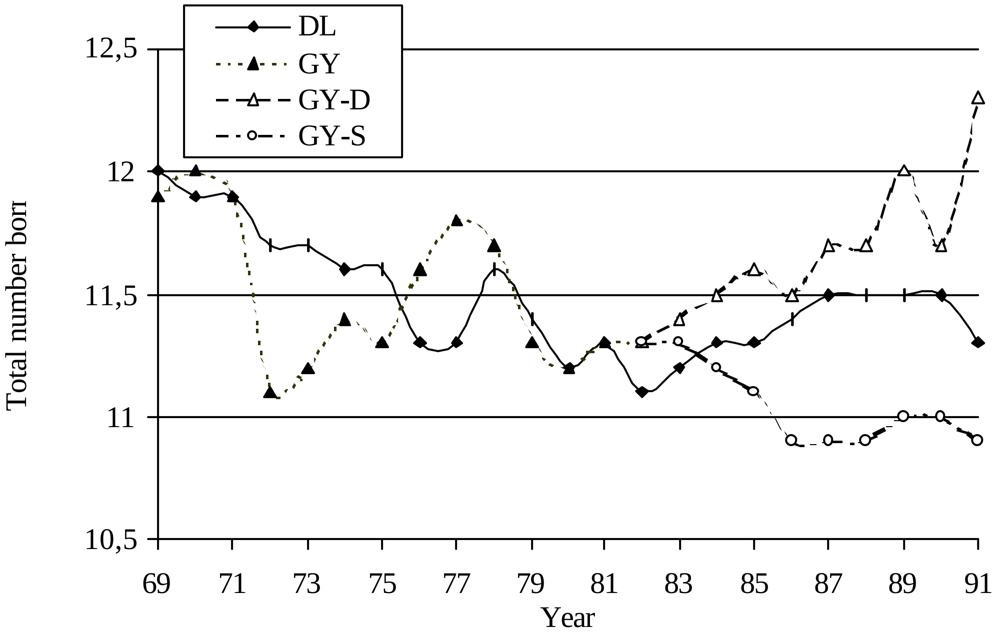


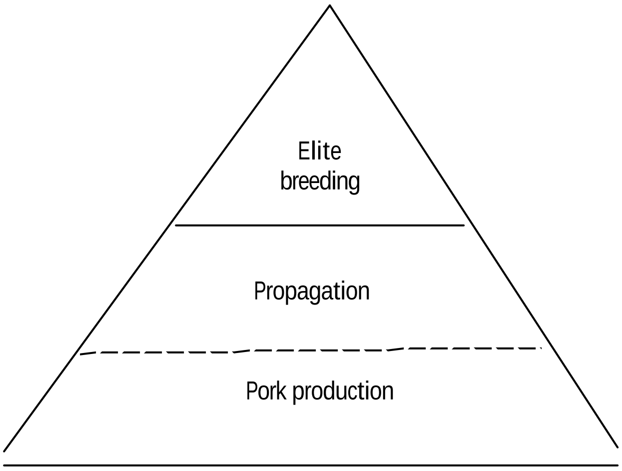
Figure 2.6 Phenotypical trend in litter size in second and higher parity in Dutch landrace pig (DL) and Great Yorkshire (GY) mother line (GY-D) and father line (GY-S), from 1969 to 1991 (Merks, 1998)

2.8.2. The structure of the pig breeding sector

The introduction of specialised breeding companies has shaped the sector according to the usual hierarchical pyramid of elite breeding companies at the top of the pyramid, followed by propagation farms, and with pork production units making up the base of the pyramid (figure 2.7). The elite breeding companies are constantly working to improve the genetic merit of breeding stock, the pure lines. F1 sows are a cross from specific mother lines. These are crossed with boars from the father line (pure bred or cross bred) to become an optimal crossing effect or heterosis. The F2 progeny are sold to pork production farms to be fattened.

AI has consolidated this pyramidal structure. Propagators no longer have to keep their own boars; they simply make a selection of semen depending on what the market demands. Stricter transport regulations to prevent the spread of disease have compressed the pyramid structure. Propagation and pork production holdings operate often as closed units.

Figure 2.7: Traditional structure of the pig production sector



Although pig breeding is now controlled by large industrial companies, it was not always so. In the mid-twentieth century, breeding was still the domain of many different pig breeding associations. After many mergers, there are now three large pig breeding companies in the Netherlands: Topigs, Euribrid, and Dumeco Breeding. Topics resulted from a merger of Dalland & Fomeva and the pig herdbook. Dumeco arose from a consolidation of breeding cooperatives Cofok, Costar, NCB and CHV. Next to these Dutch-based companies, foreign companies also serve the Dutch market: PIC, Seegers, Redlero Pig Development and Cotswold.

The pig herdbook now operates as the Institute for Pig Genetics (IPG) and calculates EBVs for breeding companies like Topigs. Pure line breeding is carried out exclusively by breeding companies. Individual farmers are contracted by a breeding company to carry out propagation. Breeding companies are usually subsidiaries of an industrial conglomerate which operates at all levels of the chain, from breeding, propagation, meat production and feed supply to slaughterhouses and meat marketing. Very few pig farmers in the Netherlands are truly independent; most are under contract with one of these industrial companies.

2.8.3. Breeding in the Dutch organic pig sector

Interviews with organic pig farmers in the Netherlands revealed that most use conventionally bred porkers. In a 2001 study of ten farms, Bestman et al. found that most sows were two-way or three-way crosses of Dutch landrace (NL) and Great Yorkshire (GY), or of Large White (LW) or Duroc. Only one farm stood out, as it kept Piétrain sows. Farmers' reasons for using these breeds, or rather crosses, are summarised in tables 2.7 and 2.8.

Hybrid	Traits of sows
DL x FL x LW	steady temperament
LW x GY x Duroc	robust animals
DL x FL	good mother traits inherited from FL
GY x DL (reversed)	hardier sows because of NL boar

Table 2.7 Primary traits of hybrids used in organic pig production, as reported by individual farmers (Bestman et al., 2001; De Wit, 2001; Nauta, 2000). DL = Dutch Landrace, FL = Finnish Landrace, LW = Large White, GY = Great Yorkshire

F1 Boar	Traits of porkers (F2)
Duroc	strong legs, hardier animals
Piétrain	meat quality
Crusta	hardier animals
GY	good percentage of meat
GY x Piétrain	good percentage of meat; meat quality
GY x Duroc	hardier animals

Table 2.8: F1 boars and primary traits of F2 progeny for pork production, as reported by individual farmers (Bestman et al., 2001; De Wit, 2001; Nauta, 2000)

Sows were served naturally by a farmer's own boar in about 50% of cases on the farms in Bestman et al.'s study (2001). AI predominated on four farms. One farm only used natural serving. Many farmers feel that they could not do without AI. De Wit (2001) obtained a lower estimate for natural serving. All farmers owned a boar, but used him primarily to identify in-season sows. The sows were primarily inseminated artificially.

In general, these organic pig farmers said they had no major difficulties with conventionally bred animals. The following problems were reported:

1. porkers get too fat because they are kept on straw
2. slower growth
3. piglets squashed by sows
4. leg problems
5. aggressive temperament
6. poor resistance (general and specifically against worms)

Many of these problems more or less solved by the pig farmers themselves by selecting the right breed or hybrid. For example, excessive body fat can be countered by using a 'super F1 boar'. Weak legs or weak resistance can be improved by crossing with 'a hardier breed'. Piglet mortality because they are squashed or trodden on by sows, and aggressive temperament have proven to be persistent. In the hope of alleviating these problems, many pig farmers are using sows resulting from a cross with the Finnish Landrace (FL) breed. The sows' weight is also a factor in piglet mortality caused by sows. If they are too heavy, they tend to 'flop down' squashing any piglet which might happen to be lying there. The temperament of the piglets is then important. Lively piglets have a better chance of survival.

3. Organic farming and its development

3.1. Brief history of organic agriculture

Organic agriculture evolved from the work of different pioneers in Switzerland, England, France and Austria, who all had their own reasons for pursuing alternative methods of food production. What these pioneers shared was the wish to realise the most natural possible production of food without needing to resort to synthetic chemical fertilisers and chemical pesticides. It is no coincidence that these streams arose in the early 20th century, when the recent discovery of chemicals was being warmly hailed by society. In a historical study, Boeringa et al. (COBL, 1977) identified almost twenty different forms of alternative agriculture.

Initially, there were two main streams in the Netherlands: ecological (Eko) and biodynamic agriculture. The fairly recent harmonisation of international regulations has led to a single overall standard for the different alternative streams: 'organic'. The principle aims of organic production and processing are laid down by IFOAM. Within organic agriculture, however, it is still possible to trace the various distinct streams back to the pet theories of their founding fathers. For example a few minor streams prescribed the use of certain bacterial cultures (e.g. organic-biological agriculture developed by Rusch and Muller, with an important role for symbiotic bacteria which produce lactic acid) or coral algae (Lemair and Boucher's method) to restore the organic equilibrium. Howard and Balfour's organic method centred around manure composting and optimising mineral reserves in the soil by planting deep-rooting clover and herbaceous species. Nitrogen fixation by mycorrhiza played a crucial role in their method.

One of the oldest streams in organic agriculture is biodynamic agriculture which was developed by the philosopher and anthroposophist Rudolf Steiner after a group of farmers had asked him about his vision on agriculture. Steiner wrote a series of essays on a type of agriculture which takes into account the relationship between the spiritual and the material and cosmic influences on the ecosystem. This agricultural method strives to realise a sustainable relationship of cooperation between mankind and the natural world, so that the earth as it evolves and develops may continue to nourish man. In addition to his agricultural essays, Steiner also wrote about medicine, education, economics and the study of man. Biodynamic agriculture as we know it today has been shaped by all elements of Steiner's legacy.

In the Netherlands and other countries, most of the growth in the organic sector can be attributed to the so-called Eko stream. Few farmers have converted to biodynamic agriculture since the early 1990s. The reason for this can be found in market structures. Traditionally, there was a good market organisation for biodynamic products, a factor which led many converting farmers to decide in favour of biodynamic production. The standards for Eko certification, which are based on IFOAM and European regulations for organic production[1], are less stringent than those for biodynamic certification (the Demeter mark), but until fairly recently the market for Eko certified products was underdeveloped. With the Eko market now developing strongly, converting farmers prefer to work according to the Eko standards. Despite the different standards, there are several overlaps between biodynamic and Eko farming. Interestingly, a number of long-standing Eko farms recently expressed their interest in switching to biodynamic production, feeling that the Demeter standards would fit better with their more principled approach to farming. An additional barrier has been removed for these farmers by the biodynamic certifying body: the use of biodynamic supplements is no longer compulsory.

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[1] The European Commission first laid down standards and provisions for organic production in Commission regulation 2092 in 1991. In 2000, the Commission amended this regulation with new provisions on livestock production.

3.2. Basic principles of organic agriculture: what is organic farming?

Organic agriculture is often described as an agricultural method without the conventional supplements of synthetic chemical fertilisers and pesticides. The aims and principles of organic agriculture go much further than this simple negation, however. Generally, organic farming methods are rooted in knowledge of ecological (natural) processes. Farming by definition however implies some form of cultivation, which will always affect and compromise nature. Organic farmers try to minimise the negative effects on natural processes and to restore damage wherever possible. Cover crops might be grown to minimise the leaching of minerals; legumes to counter nitrogen deficits. Diversity on the farm is maintained by nurturing natural flora and fauna in field margins. Nature, natural processes are often a *Leitbild* which guides farmers in their management choices. Processes within the natural ecosystem are studied in order to develop actions which take account of nature (Baars, 1990a, De Smidt, 1978). Alrøe et al. (1998) described the aims of organic agriculture as follows:

> *"Organic agriculture is conceived as a self-sufficient and sustainable agro-ecosystem in equilibrium. The system is based as far as possible on local, renewable resources. Organic farming is based on a holistic vision that encompasses the environmental, economic and social aspects of agricultural production, both from a local and global perspective. Thus, organic farming perceives nature as an entity which has value in its own right; human beings have a moral responsibility to steer the course of agriculture such that the cultivated landscape makes a positive contribution to the countryside."*

The guidelines for biodynamic agriculture and the IFOAM guidelines both make a clear distinction between aims, guidelines and standards. Standards are the minimum conditions for organic production, and compliance can be monitored fairly easily. But the nature of some actions are such that they defy the setting of standards. Not all aims and principles can be translated into assessable standards at a more practical level. Organic agriculture can be said to have a legal body, the set of assessable standards laid down by law, which is inextricably linked to what we can only call the spirit of organic agriculture (Baars, 2000a). A detailed summary of IFOAM's principles and aims of organic agriculture can be found in appendix 1. These principles and aims mainly deal with:

1. The interrelationship between natural processes

Nature is like a web of interconnected ecological processes. We can distinguish processes at four levels: soil, plant, animal and man. A change in any given process at any level will always impact on other processes. The interdependence of natural and ecological processes forms the basis of the organic philosophy. In organic agriculture, farmers should run their farms in a way that minimises the impact on other ecological processes.

2. A good soil fertility

The soil is of primary importance in organic agriculture. The soil is literally the basis of food production for man and animals. Natural products need to grow in soil which is fertilised with natural organic fertilisers of plant and animal origin. The quality and health of plants play an important role in livestock health, as plants are the animals' only source of nutriments, minerals and trace elements. A good variety of plants ensures a healthy balanced diet.

Modern conventional agriculture prefers to grow monocultures, for example perennial ryegrass which is fed to cows and supplemented with minerals and trace elements to prevent dietary deficiencies. An organic system aims to provide all the necessary nutriments with home-grown fodder. This can be achieved by repeated sowing of herbs in grassland to fix essential minerals and trace elements in the soil and thus ensure that these nutriments are present in fodder. Of course, this does mean that these minerals and trace elements have to be present in the soil to start with.

3. Preventative approach to crop protection and animal health

Diseases and plagues can be prevented by adapting production methods. In arable production for example, crop rotations should be extended to 1:6 or 1:7, so that species-specific diseases cannot survive in the soil until the same crop is grown again. A long crop rotation also enhances soil fertility. The result is a more resilient crop with a stronger resistance to diseases and plagues. In livestock production, natural and wholesome rations are the basis of animal health (see above). But animals' resistance to disease is also boosted through other preventative measures to reduce the pressure of infection and improve animal welfare: for example sufficient space for movement and natural behaviour and access to outdoors.

4. Autarky through closed cycles

Organic agriculture aims to close cycles at farm level, but autarky can also be pursued at other levels. For example, organic agriculture is still highly dependent on products and surpluses from conventional agriculture: breeding stock (plants, seeds, animals), fodder and manure. The organic sector however should be developed to stand on its own, to function independently of these non-organic inputs. The goal at farm level is to achieve a high degree of self-sufficiency which results in unique farms each with their own character and style. Self-sufficient farms minimise losses and thus succeed in producing food in a sustainable manner. Food security need not be a problem. In a closed system with few if any inputs of breeding stock (plants and animals), internal selection ultimately brings forth types which are optimally adapted to the farm system. In the long run, this adaptation takes place at every level of the organism, right down to the genome.

The ideal closed organic production unit is a mixed farm. In the Netherlands today, most farms are specialised farms, but there are a growing number of so-called partner farm systems in which different specialised farms work together closely to regain the advantages of mixed farms (Nauta et al., 1998, 2001).

3.3. The organic sector in figures

Organic production grew explosively in the 1990s. In the Netherlands, there are about 1400 organic farms today, compared to 350 in 1990. These 1400 farms have a total area of 25,000 ha or 1.4% of the total agricultural area in the Netherlands. The greatest growth has been in organic dairy farming, which now accounts for 42% of the total organic area. Core data for the sector is presented in Table 3.1. Government policies are aiming for continued growth of the organic sector in the Netherlands for example to 10% of the total agricultural area in 2005 (Ministry of Agriculture, Nature Management and Fisheries, 2001). This would be 200,000 ha in all of which 120,000 ha would be grassland for 100,000 organic dairy cows.

The sector's growth rate in the Netherlands is exemplary for the situation throughout Europe. Between 1993 and 1998, the total area of organic agriculture in the European Union grew by an average of 26.8% per year and now comprises almost 3% of the total agricultural area in the EU (see Table 3.2). The strongest growth occurred in countries where agricultural production has always taken place extensively and synthetic chemical fertiliser use is less prevalent: Greece, Italy, Portugal and Spain. In countries which are not part of the EU, 362,957 ha are farmed organically. This breaks down into 0.28% of the total agricultural area in accession countries and 2.73% in the EFTA countries, including Switzerland where 9% of the total farmed area -- or 95,000 ha -- is cultivated organically (SÖL, 2001). In Denmark, Austria and Italy, however, demand for organics is stagnating, so that products there are sometimes sold for conventional prices. This has led some farmers to drop out of organic production.

no. of organic farms	1390
% of all farms (93,820)	1.48
no. of organically farmed hectares	27,820
% of total agricultural area (2 million ha)	1.39
no. of certified farms	1121
no. of farms in conversion	270
Distribution of organic farms per sector, in %	
vegetable growing	
fruit growing	23.3
arable	5.1
livestock	24.7
other (incl. mushrooms and ornamental plants)	43.3
	3.7

sources: SKAL, CBS

Table 3.1: Organic agriculture in the Netherlands in 2001

	area (ha)	% of total farmed area	no. of farms	average annual growth,1993-1998* (%)
Austria	271,950	7.96	19,031	15.5
Belgium	20,263	1.47	628	12.3
Denmark	165,258	6.15	3,466	28.2
Finland	147,423	6.79	5,225	25.6
France	370,000	1.31	9,260	13.9
Germany	546,023	3.20	12,732	10.7
Greece	24,800	0.71	5,270	78.3
Ireland	32,355	0.75	1,014	?
Italy	1,040,377	7.01	49,790	46.6
Luxemburg	1,030	0.81	51	?
Netherlands	27,820	1.39	1,391	16.1
Portugal	50,002	1.31	763	33.6
Spain	380,838	1.49	13,424	36.1
Sweden	171,682	6.25	3,329	12.9
United Kingdom	527,323	2.85	3,563	18.1
Total EU	3,777,144	2.94	128,937	26.8

*sources: www.organic-europe, Stiftung Ökologische Landbau, *Instituut Milieu Vraagstukken, VU*

Table 3.2 Organically farmed area in the European Union in 2000

There is very little growth of organic production in intensive livestock sectors in the Netherlands (table chickens, egg production and pig production). This is partly due to the enormous contrast between the industrial, intensive character of conventional production and the organic, land-using approach in which animals also have access to outdoor runs. A covenant has been agreed with the pig production sector which aims for 100,000 organic pork pigs per year in 2005. Currently, there are about 35 specialized organic pig farms with annual capacity for 1,200 sows and 9,000 porkers. About 19,000 pork pigs are slaughtered per year. Next to these farms about 40 farms do have a small number of sows and finishing pigs in combination with other specialities. As for table chickens, only five holdings in the Netherlands currently produce organic broilers. The largest produces about 12,000 broilers per year. There are about 35 organic laying hen farms with a total of 90,000 laying hens. Their production represents 0.5% of the total egg production in the Netherlands.

On a final note, a fast-growing sector in the Netherlands is organic dairy goat production. There are now 50 of these farms, with a total of about 10,000 organic dairy goats.

3.4. Future perspectives

The recent growth in number of farms and land area under organic production raises the question of where the sector should go from here. The rapid growth has put pressure on the fundamental principles of organic production. On many recently converted or converting farms, it appears that the conversion to organic only touches the surface of what essentially remain conventionally run farms.

In conventional agriculture, a division is becoming apparent between modern factory farms and farms which focus more broadly on rural development (Frouws and Van Broekhuizen, 2000). As Table 3.3 shows, factory farming strives for greater uniformity and standardisation in primary production world-wide. This technological form of government-funded agriculture (Van der Ploeg, 2000) chooses extreme specialisation to reach its goal of optimum production. Every traditional link between production and natural processes is broken. Animals are production units for specific single products which are produced in bulk for industry and the market. More and more animals are being kept strictly indoors in highly controlled conditions. Verhoog (2001a) has described this development perspective as 'enlightened anthropocentric'.

In the second stream, in which agriculture is seen as an integral component in rural development, the focus is on more traditional small-scale production of a broad range of quality products. Farms are multifunctional, but all functions are interconnected. The different components of the farm system are in harmony, thus producing an optimum return. Products are marketed for primary consumers. Animals' intrinsic role in the system is acknowledged.

Modernisation / Industrialisation	Rural Development
-industrialisation	-more traditional methods of production
-uniform and standardised primary production	-diversification / variety
-globalisation	-local focus
-specialisation	-multifunctional
-functional differentiation	-interconnected functions
-break with natural processes	-link up with natural processes
-further differentiation of the supply chain in separate components	-strive to reintegrate all aspects of production on the farm
-more market-dependent reproduction, greater dependence on external resources (bringing in fertiliser, concentrates, genes etc. from specialised businesses)	-autonomous reproduction, depend on own resources (self-sufficient in fodder, breeding stock, soil fertility, knowledge)
	-optimisation through harmonisation of components
-optimalisation of separate system components	
-reduction of animals to production units	-intrinsic value
-added value produced by industry	-added value produced on farm
-one-dimensional concept of quality (technical and biological minimum requirements)	-multi-dimensional concept of quality (taste, identity, purity, etc.)
-markets are a given for primary producers	-primary producers actively develop markets
-high-tech technology	-adapted technology
-relatively low flexibility	-relatively flexible (multiple future perspectives)

source: Frouws and Van Broekhuizen (2000)

Table 3.3 The two poles in dairy farming.

There is a similar differentiation taking place in organic agriculture. Klawer (2001) differentiated four types of farm management in a study of organic dairy farmers in the province Friesland based on operational differences as well as underlying differences in farmers' attitudes towards nature in its broadest sense. These styles of farm management are: farming with conviction, farming to standards, farming for social renewal and integrated farming. Farm management focused on standards most closely resembles the industrialisation stream in conventional agriculture. These type of farmers continue to pursue high milk yields per cow after their conversion to organic. Their production complies with the organic standards; they are not interested in investing in nature beyond what is legally required. Farmers whose motivation is social renewal set up farm shops and campsites to bring tourists and visitors to their farms. Farmers with strong convictions and integrated farmers are most concerned with nature and broaden their activities in a variety of ways to encompass nature goals.

Verhoog et al. (2001b) of Louis Bolk Institute have identified three streams based on farmers' interpretation of the concept of naturalness in relation to organic production (Table 3.4).

I: Substitution farming	II: Agri-ecological farming	III: Integrity-based farming
no synthetic chemical fertiliser; no chemical pesticides; organic substances; symptom-focused; conventional management within organic boundaries; economies of scale; specialisation / standardisation; efficient use of resources;	first three points of I, but also: natural processes, ecological coherence; respect for animals; important goal = closed cycles; holistic and idealistic; preventative disease approach; differentiation; tackle the cause of things;	as II, but also: guiding principle is the dynamic character of nature; integrity of animals and the system; homeostasis, system stability and equilibrium; idealistic; sometimes spiritual;
farmer=master	farmer=steward / participant	farmer=partner

Table 3.4: Streams in organic agriculture according to Verhoog et al., 2001b

So-called substitution agriculture in many ways resembles factory farming in conventional agriculture. The word substitution refers to the fact that production does take place in compliance with organic rules, but the general approach to farming continues to be conventional. For these farmers, conversion was based on economic motives and the attraction of a lucrative organic market. These farmers keep their cost price low by optimising conventional as well as organic techniques and realising economies of scale. Kirschenmann (1998) and Pollan (2000) have described how in the United States, this type of organic agriculture is increasingly being taken over by multi-national companies aiming to develop the organic fast-food market.

Agri-ecological processes are a central concept in the second stream in organic agriculture. Here, farm management is aimed at efficient production without causing damage to ecosystems. This means that the best possible use is made of natural resources on the farm and inputs are restricted. Production should be tied to the land. These farms tend to be smaller and have been producing organically longer than the so-called substitution farms. These farmers converted to organic production because they rejected the agri-industrial principles of growth, economies of scale and more intensive production. For them, being organic entails more than compliance with the standards set by the EU and organic certifying bodies. Their belief in broader principles leads them on an ongoing quest for agriculture based on natural processes, farming on a human scale which does not destroy the chances of farmers in developing countries, which seeks direct contact with consumers and is in harmony with the local culture, ecology and landscape.

Finally, the third stream of organic management is carried out by farmers who put the integrity of the system and the animals within the system first. In this view, the soil, plants and animals and the farm as a whole are regarded as organisms with an intrinsic value or integrity of their own. Farm management explicitly takes account of this intrinsic value. On these farms, operations are adapted to the dynamic character of nature for maximum stability and equilibrium in the system. Farmers in this stream sometimes take a spiritual approach to farming practice. This stream dovetails with the principles of biodynamic agriculture (Verhoog et al., 2001b).

This classification also represents different developmental stages for organic farms. The classification, once made, is not fixed in time. Many newly converted farmers practice substitution agriculture, which could be called the first stage of development in organic production. These farmers want to produce organically but do not possess the capabilities for doing so at all levels. In practice, their approach is still strongly governed by conventional strategies. As they go, however, they learn more about organic agriculture and start developing their farms in accordance with organic values and principles (Bloksma, 1991), a process which can be depicted in the classification as a movement to the agri-ecological stream. This development is supported by a study among organic dairy farmers (Nauta and Elbers, 2000), summarized in Table 3.5, which showed that longstanding organic farms had a more extensive production. Intensively producing farmers indicated that they were seeking ways to make production more extensive and less dependent on inputs from conventional or agri-industrial sources.

	Converted			
	before 1991	1991 to 1995	from 1996	average
number	32	16	108	156
biodynamic (%)	50	20	1	13
no. of dairy cows	43	57	50	49
area (ha)	41	51	37	40
kg milk / ha	6,780	7,450	9,027	8,200
milk quota	278,000	380,000	334,000	328,000
kg milk / cow	6,504	6,487	7,078	6,902
fat (%)	4.36	4.36	4.38	4.37
protein (%)	3.39	3.43	3.5	3.47

Table 3.5: Core data for organic dairy farms in relation to conversion date

In interviews with farmers, we learned that breeding is rarely a priority immediately after conversion. Farmers' first concerns are yield, soil fertility, nutrient cycles and weed control. An interest in obtaining animals which are more suitable for conditions on their farm may develop after some years of organic production. Verhoog et al.'s classification of organic management streams (Table 3.6) can also be used to order the different attitudes and actions in the organic sector with respect to breeding. Thus farms in the 'substitution' stream or phase would use breeding stock from conventional breeding, with some reservation about the use of ET. Indeed, most recently converted organic dairy farmers in the Netherlands do rely on conventional breeding (Nauta and Elbers, 2000, see also 2.7). The agri-ecological stream or phase makes more use of alternative breeding methods. New crosses are made to obtain desirable characteristics, and animals' merits are evaluated on broader criteria than only estimated breeding value. Some farmers in this stream call for a different approach to estimating breeding value (see chapter 2).

In summary, Figure 3.1 shows the position of all these streams or styles of agriculture in relation to each other. The streams depict the wide range of possibilities for the further development of the organic sector in general, and of organic breeding. To a large degree, however, the direction in which developments will take place will depend largely on organic legislation, which in turn is a result of developments in the sector.

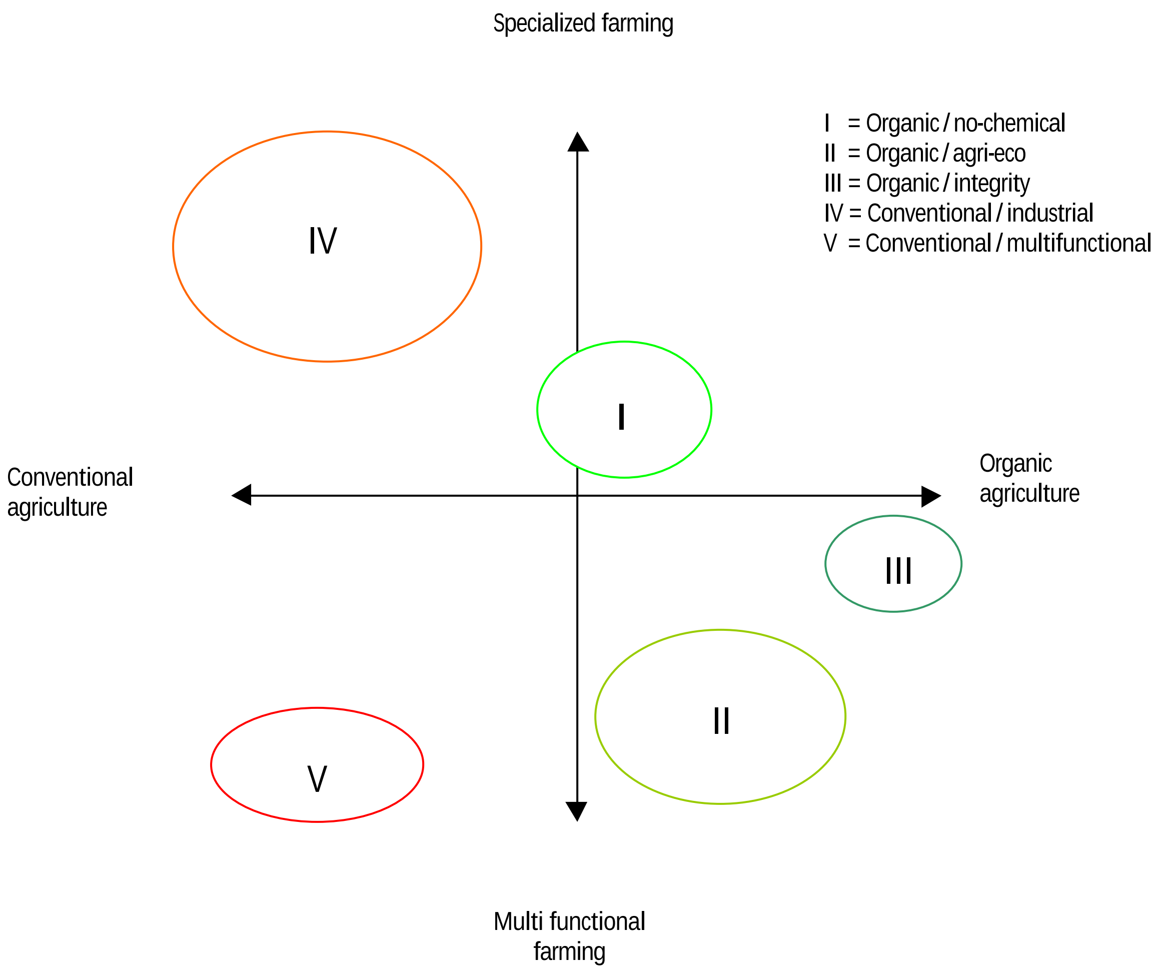


Figure 3.1 Diagram of the different agricultural streams in The Netherlands.

	perspective of naturalness		
	substitution	agri-ecological	integrity
cognitive (principles)	1. Breeding is the genetic improvement of (parent) animals at DNA level, Environment is adapted accordingly and standardised world-wide. 2. The best animals are selected from the global population,knowledge is based on quantitative genetics. 3. Intervention at chemical level (hormones) is rejected.	1. Breeding is based on animal ecology: -type (build, useful lifespan); -animal and environment 2. Breeding is finding the right animal for a given environment. 3. Breeding must not upset animals' inherent equilibrium. 4. Breeding is based on quantitative animal models, efficient production is supplemented with other values.	1. Breeding is distilling characteristics through an understanding and knowledge of the species, type and individual animal: -understanding of the animal as type -understanding of its role in the farm as a whole. This reinforces the animal's intrinsic value in a cultural environment.
emotive (attitudes)	1. It is man's right to breed animals for his own purposes and well-being. Animal is assessed in terms of instrumental value to man. Respect at genetic level (i.e. no genetic modification). 2. Animals may be controlled and formed to man's wishes.	1. It is man's right to breed animals for his own purposes, provided animals and their environment are used in a sustainable manner.	1. Man breeds according to a vision on the animal as a being; breeding is process of refinement based on feeling of equality and devotion to the animal. 2. Breeding based on qualitative assessment of the animal. Artgerechtigkeit. Respect for the animals' integrity or intrinsic value.
normative (actions)	1. Breeding aims to increase production efficiency; limited choice of bulls (no ET). 2. Breeds are not important, 3. Environment is adapted to the bred / developed animal. 4. AI allowed for pragmatic reasons, 5. Breeding, propagation and use are distinct activities.	1. A balanced breeding animal w.r.t. type and additional breeding values (functional, secondary characteristics). 2. Lifetime production breeding based on additional breeding values. 3. Search for appropriate regional breeds for a given farm type (importance of genotype x environment interaction recognised).	1. Search for a new breeding system based on own knowledge of / view of the animal. Harmony and purpose w.r.t. the animal characterise this view. 2. Animals have a right to natural reproduction. AI rejected. 3. Family breeding with own bulls results in breeding on genotype x environment interaction.
practical	1. Search for efficient, high-yielding male and female breeding animals without ET background, no use of IVF or OPU. 2. Hybrid crosses in all animal groups.	1. Bakels' line breeding and rotation crosses. 2. Durability index in conventional breeding. 3. Ökologische gesamtzuchtwert. 4. Triple aAa system; Endendijk's view of individual animals;	1. FH breeders: family breeding; foundation breeding farms. 2. Schad: an animal's purpose in the mammalian order. 3. Bakels / Haiger: ideo-typical representation of the cow

Table 3.6: Approaches to breeding in organic agriculture. Based on the streams identified by Verhoog et al. (in development, 2001).

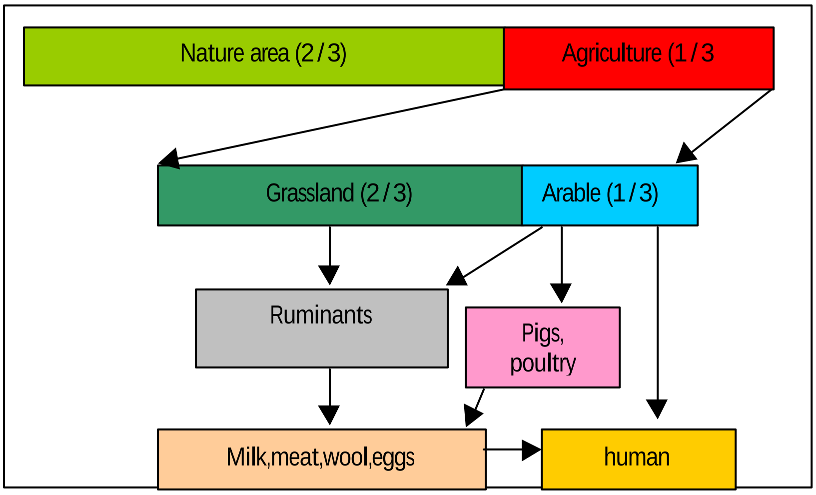
3.5. The role of animals in organic agriculture, general principles and characteristics

Regardless which type or stream of farming they practice, organic livestock farmers are more dependent on natural sources in the farm environment because they cannot regulate natural processes with strategic use of synthetic chemical fertilisers, chemical pesticides or antibiotics. Earlier, we described in technical breeding terms how characteristics are selected. In this section, we indicate which characteristics would be desirable from an organic point of view.

3.5.1. Efficiency in the system and production in keeping with their nature

In general, every organic farmer wants livestock to produce efficiently while complying with organic standards. In organic agriculture, however, efficiency is a broad concept encompassing the use of local and renewable resources, and environmental, economic and social aspects of cultivation both locally and at a global level (Alrøe et al., 1998; IFOAM, 2000). Haiger et al. (1988) stated that ruminants should be used to convert roughage that cannot be digested by man, and not be allowed to compete with man for food. After all about 66% of the world's agricultural land is in use as grass land. In a similar vein, pigs and poultry should be fed agricultural waste products which are not suitable for human consumption. This is visualized in Figure 3.2.

Figure 3.2: The role of animals in the agri-ecological system (Haiger, 1988).



Other reasons for this are that, in terms of nutrient requirements, animal production is less efficient than plant production. Maximum efficiency in dairy production varies from 30 to 50%, while an efficiency rate of 70% is easily achieved in crop production (Van Bruchem, 1999). Van Veluw (1994) proposed that animals should be given a place on mixed farms on the basis of their role in the agri-ecological system. Animals also have a place in the biodynamic vision of the farm as an organism (Baars, 1990a, Klett, 1992). In these systems, animals must be capable of converting the rations of roughage and waste products efficiently into food for human consumption. To do so, cattle must have a large rumen. In pigs, digestion of more roughage fodder will take place further on in the intestines, so that breeding should focus more strongly on this characteristic. Laying hens should be able to produce well on a diet containing less protein than is usual in the laying sector, since protein must be reserved to feed people.

3.5.2. Animal integrity and welfare

In the principles of organic agriculture, nature and nature values are an indivisible entity, an organism with its own identity and integrity (Alrøe et al., 1998). The integrity of nature also encompasses animals' integrity. Integrity refers to animals' wholeness and the absence of mutilations, but also to a state of species-specific equilibrium and the ability to live independently in conditions appropriate to the animal (Grommers et al., 1995). This implies that animals must be able to express their natural, species-specific behaviour and be able to reproduce naturally. This concept is therefore a negation of embryo transfer. Finally, animals must have the capacity to adapt to local conditions without this negatively affecting their health and welfare (IFOAM, 2000).

Integrity also means that animals should be used for purposes which are in keeping with their characteristics. Cattle are ruminants with multiple stomachs designed by nature to digest roughage (Haiger, 1988; Rist, 1987). Pigs and poultry are omnivores that live from whatever food they manage to find while rooting or scratching in the ground. In a mixed farm system, their role should be to eat whatever is left (see previous section).

Feeding and keeping animals in a way that better suits their nature means that the animals have more freedom to be themselves. This may enhance their welfare. Appropriate or normal social behaviour should always be considered when determining desirable characteristics. Horns, tails and beaks should remain intact, but steps should be taken to prevent animals injuring each other. It is important to facilitate natural behaviour in every stage of life. Sows, for example, should be able to walk freely, but they should not display aggressive behaviour towards their young or smother them when they lie down. At the same time, piglets should be lively and alert and jump out of the way when the sow lies down.

Natural species-specific behaviour also means loose housing systems and going outdoors. This should be facilitated by giving animals access to an outdoor run or pasturing them. But they must also be able to cope with this freedom and outdoor access. It almost sounds silly but the animals must therefore be able to walk a distance! Further, they should not become aggressive when exposed to daylight, they should be able to search, scratch, root, graze, roam and so on. In conventional agriculture, breeding no longer selects for these characteristics because the animals are kept indoors in housing systems which prevent undesirable social interactions as much as possible.

3.5.3. Resistance to disease

Antibiotics may only be used for curative purposes when an animal is so ill that its welfare is at stake (EU, 2001). Preventative use is not allowed. Animals are given the opportunity to fight off illness themselves. In general, organic livestock should be stronger, more robust and have enough reserves for a good natural resistance to disease.

3.5.4. Genetic modification

Finally, the genetic modification of animals, or in fact of any organism, is not allowed in organic agriculture (IFOAM, 1994).

4. Points for discussion

Animal breeding is closely connected with developments in livestock production on a broader scale. A discussion about animal breeding in organic agriculture must therefore always include discussion of organic production systems and developments. Elsewhere in this report, we have described developments in the sector in order to facilitate discussions about organic breeding.

Conventional breeding has followed a course which in many ways conflicts with basic organic principles, creating a dilemma for organic farmers who are still largely dependent on these breeding programmes. The problems and tension resulting from this dissonance in views can be divided into three general categories: ethical concerns, ecological concerns and technical breeding concerns. In this chapter, we look more closely at these concerns.

4.1. Reproduction technologies

The first specific ethical concern is the use of artificial reproduction technologies in conventional breeding. Reproduction technologies are particularly important in cattle breeding (see section 2.5). According to organic principles the use of these technologies is not allowed in the organic system, as they are detrimental to the welfare and integrity of animals. The only technique which is excepted from the general ban is artificial insemination (AI).

Artificial insemination

Nearly all dairy and pig producers in the Netherlands, regardless of whether they are conventional or organic, use AI. Our assumption in this paper is that AI will continue to play a role in organic agriculture, as there are several practical aspects which support the case for AI. In particular, AI prevents the spread of diseases (Den Daas and Van Wagtendonk, 1993) which debilitate animals as well as being a major business liability. On the other hand, organic principles also state that animals' own resistance to disease should form the basis of disease prevention; these principles clearly do not oppose natural serving.

Strictly speaking, if embryo transfer is rejected on principle then it would follow that AI is banned as well, as many of the same arguments apply. In that case, breeding programmes for organic agriculture would have to be based on regional breeding or on-farm breeding programmes (described in chapter 5).

With AI, a large part of the reproductive process occurs outside its natural context. Male animals have no contact with female animals, their ejaculation takes place in an unnatural setting at the AI station. Semen is diluted and subjected to several sharp fluctuations in temperature. No one really knows what the effects are of this treatment of the semen and of the unnatural "servicing" of the female. An organic hypothesis is that these artificial techniques -- artificial in the sense that they take place outside the body – affect the reproduction process to such an extent that the vigour and vitality of resulting progeny is diminished (Spranger, 1999).

According to organic principles, animals must be able to reproduce independently (IFOAM, 2000). By using AI as the basis of breeding and propagation for an extended period of time, the capacity for independent reproduction might decline in the selection process, ultimately leading to the loss of this quality. This can be evident in direct fertility traits. For example, many cows do not show heat anymore, this reduces the chance of successful fertilisation and the desire to mate (Spranger, 1999; Haiger, 1999). Other manipulations such as oestrus synchronisation and embryo transfer are then necessary to raise reproductive success. Indirect traits such as body weight may also play a role in reduced reproductive success. Male turkeys (toms) for example have become too heavy to mate with hens. Bulls, too, are often too heavy for lightly built milk-type heifers or cows. AI is then the only possibility for reproduction.

Another disadvantage of AI can be the fact that female traits such as milk production must be passed on by male animals. In addition to the DNA in the cell nucleus, an ovum contains additional genetic information in the cytoplasm. This information can only be passed on by the mother to offspring, and is lost to subsequent generations when breeding is based on AI. Sperm only carry a cell nucleus. In their theories Bakels and Weeks (triple A) mentioned the importance of breeding bulls from bulls and cows from cows, in order to utilize this gender-based dimorphism (Spranger, 1999; Postler, 1998). In this breeding system, bulls must have a typically male appearance and not possess female traits as is often seen in bulls from conventional programmes (Bakels, 1988).

The possibilities of the AI technology also threatens the variability in a population. One AI bull can take the place of many naturally serving farm bulls. In Holstein breeding, the use on a worldwide scale of only a few dozen bulls, resulting from even fewer families, has led to considerable loss of variability. This is in conflict with organic agriculture's goal to maintain or increase diversity.

In addition to these objections concerning the AI technique itself, the housing of AI bulls and boars in conventional AI stations does not meet organic standards. In particular, the animals do not have access to outdoors since international regulations came into effect requiring animals to be free of viral infections such as IBR, leptospirosis and BVD. The recent outbreaks of classical swine fever and foot-and-mouth disease in Europe will only lead to a further tightening of these rules. Many bulls are housed in tied-up barns, a type of housing which is no longer allowed in organic farming. Finally, the animals are not fed organic rations.

Embryo transfer

The production of embryos by Multiple Ovulation and Embryo Transfer (MOET) or Ovum Pick-Up (OPU) and In-Vitro Production (IVP) is commonplace in the conventional dairy cattle breeding industry and to a lesser degree in pig breeding as well. Many organic farmers bring in animals or semen from conventional breeding, thus indirectly making use of the products of ET technology. This indirect use is now a point of contention, as embryo transfer is banned in organic livestock production.

One of the main reasons for this ban is the fact that ET in combination with MO and / or OPU-IVP diminishes animals' welfare and integrity (Schroten, 1992). The hormone treatment necessary for multiple ovulation causes abnormal swelling of the ovaries which may last up to a week and can cause considerable discomfort to the animals. From human IVF it is known that such treatments cause considerable pain to woman as well. Owners or handlers of cows which have undergone this treatment have reported that the animals appear unwell and give less milk. In farmers' own words: "It's a shock to their system." "They become scared of you." OPU and ET are invasive techniques which directly impinge on animals' integrity. OPU donor cows undergo this operation twice a week. Donor cows for MOET are subjected to hormone treatment for super ovulation every five to six weeks.

ET recipient cows have more problems during pregnancy and parturition. Pregnancy rates with these methods range between 40% and 60%. There are indications that MOET results in higher rates of embryo mortality, spontaneous abortion, stillbirths and post-natal mortality. MOET calves tend to be heavier at birth, thus giving more troublesome calvings (Smith and Wilmut, 1990). Some breeders have reported that ET calves do not grow as well as calves resulting from natural mating (Engelen, Endendijk; verbal communication), although this is yet to be confirmed by science. Last, the introduction of OPU has increased the incidence of deformed calves with lack of vigour (Boerjan et al., 2000; Gerry et al., 1995; Landsbergen, 1996).

From the above, it is clear that the combinations of MOET or OPU- IVP-ET have negative effects on reproduction and animal welfare, but it is difficult to attribute these effects to one or other specific intervention, or to the fact that ET recipient cows bear "foreign" embryos. Clearly, these technologies are not in harmony with the principles of organic agriculture. The animals' integrity is invaded and their welfare diminished. The technologies also lift the process of reproduction out of its natural context. As with AI, there are indications that ET and its associated technologies negatively affect the vigour of the foetus and later of the calf.

It is necessary for organic farmers to think about whether they wish to continue using the products of breeding programmes which are based on these technologies. When asked directly about their indirect dependence on AI bulls, many organic farmers agree that this is not really desirable but they see no other possibilities. Mostly they prefer not to think about it. They are usually unaware of the scale on which these technologies are used and the negative effects on the animals involved (Nauta, interviews with farmers, 2000-2001).

In spite of all these negative aspects, we must not lose sight of the benefits of AI and ET for the organic sector. Exchanging bulls or mating cows with the neighbour's breeding bull significantly increases the risk of transmittable venereal diseases (Den Daas and Van Wagtendonk, 1993). Moreover, bulls are potentially lethal animals and keeping them on the farm requires special skills and practical knowledge; skills that are lost in a few generations of farmers.
Another advantage of using the products of AI and breeding organisations is that farmers need not keep as much youngstock in order to have a good choice of animals in on-farm breeding. Especially in countries like the Netherlands where landprices are high, the current trend of high stocking rates combined with restrictive manure regulations make youngstock a financial burden for many farms.
A specific advantage of ET is that genotypes in the mother lines can be preserved. During a large epidemic, such as foot-and-mouth disease last Spring, entire herds are culled when one or more animals is found to carry the disease. The genetic loss to individual farms is enormous, unless there is an existing store of embryos from animals in the herd. In that case, the herd can be reconstructed fairly quickly after the epidemic is controlled.
ET also enables farmers to introduce an entirely new genotype or breed on the farm in one step. Organic farmers are very interested in alternatives for the Holstein breed, for example Groningen Blaarkop, Brown Swiss and Montbéliarde. ET makes it possible for farmers to make this switch.
In Switzerland, the organic dairy sector has decided to stop using bulls which have been born from ET. Initially, the ET-free requirement applies only to bulls themselves, but its scope will be broadened in the course of five years to the entire parent line. Switzerland, however, has the benefit of a fairly large pool of naturally reproduced bulls. Such a ban would be much more difficult to adopt in the Netherlands and its neighbouring countries as many breeding programmes here, especially for the Holstein breed, have become heavily dependent on these technologies.
The ban applies to both combinations with embryo transfer, MOET and OPU-IVF, but it automatically extends to new technologies such as cloning and genetic modification, as these technologies also depend on ET.

ET and the techniques with which it is combined are most common in cattle breeding. As with AI, ET serves both as a means and a goal to optimise estimated breeding values. Not using bulls from ET will cause a modest decline in the rate of genetic progress. Conventional breeding will therefore continue to use ET. A limited definition of ET-free, in which bulls from a breeding programme can be used as long as they are not born directly from ET, would utilise to the full the genetic progress provided by the programme. But a more comprehensive definition, in which multiple earlier generations in the parent lines must be ET-free as well, would severely restrict the scope for hitching with conventional programmes for genetic progress. This is no longer possible then.

Reproduction technology in pig breeding

In pig breeding, AI is used primarily for propagation, i.e. the marketing of breeding products. Until now, AI has provided no additional value for breeders because they do not get structural feedback on the results of AI. This is being considered however, in which case AI could become an important breeding goal (Merks, verbal communication).
ET does not play a large role in pig breeding. It is used occasionally to exchange breeding material between breeding companies. Difficulties in applying this technique to pigs have prevented its large-scale application. For example, donor sows must be slaughtered before embryos can be removed from their uteri or the uteri must be shortened by surgery (Hazelegger and Kemp, 1994). However, breeders are working hard to perfect a system of embryo transfer and cloning which would yield large uniform litters (Van der Lende, 1995; Webb, 1990).

4.2. Quantitative genetics

In addition to reproduction technology, this discussion is also directed at the breeding techniques which form the framework of conventional breeding programmes. Many organic farmers and alternative breeders oppose the quantitative method of estimating breeding value. The combination of powerful statistics and reproduction technology enables breeders to provide estimated breeding values (EBVs) at a very early stage. A reliable EBV for milk production can be calculated using 100 day lactations of heifers and information about half-sisters and full sisters using the animal model (see section 2.4). Additional lactations have little use in this model, as one hundred first lactations on fifty farms will produce an EBV for milk with 90% reliability. The speed with which EBVs can be calculated has led to animals being selected at an increasingly younger age.

Critics of this method claim that it leads to the selection of early maturing animals, while a cow's peak lactation normally occurs in the seventh or eighth year of life. They hold this breeding method responsible in part for the fact that cows in the Netherlands only complete 3.5 lactations before being culled. In organic agriculture longevity is important and therefore the sector has strong reservations about the current practice. It impinges on animals' integrity. An alternative would be selection based on lifetime production (see section 2.7). Selecting for a high lifetime performance would automatically yield animals with the traits necessary for longevity. A high lifetime production also reduces the replacement rate. Animals are thus used more efficiently on the farm. Another benefit of longevity is that older cows produce stronger, healthier calves. The breeding value of these calves can be estimated more accurately because more information is available about the mother's lifetime production.

A fast EBV based on first lactations can also be seen as a selection on management. Optimal conditions due to good management will make it easier for cows with health problems to hold out for three lactations. But the problems are bound to come to the fore sooner or later. When selection entails multiple lactations, it is also possible to select on consecutively higher lactations. For example, in the method of OGZ, the first lactation counts for only 20% in the EBV because it is regarded as a warm-up for heifers which are not yet full-grown. The third lactation counts for 50%.

The shortcomings described above primarily crop up only after several decades of selecting exclusively on milk production. Recently, more functional traits are introduced in the breeding value estimations in several countries. In the Netherlands the DPS index was developed as a tool for selecting on lifetime production. However, can lifetime production be defined accurately by a handful of traits? And again, this index does not reduce the risk of a selection bias towards early maturing animals, since most information still concerns young animals. In addition, it has been shown that the statistical method on which the DPS index is currently based, does not give an accurate valuation of species which are in fact renowned for their longevity and sustained production. For example, until now not one Blaarkop bull has been given a durability value greater than 100. It has also been noticed that several high ranking bulls on the DPS index have a low index score for legs. And that the influence in practice of the durability traits only count for about 10% in the index effectively while 43% is mentioned (Scheepens, 2001). Therefore, the estimation of durability is still a matter of concern to many people.

Quantitative genetics can been seen as reductionism and "DNA thinking" as described by Lammerts-Van Bueren et al. (1998). EBVs are based on a genetic model, described in section 2.4, in which animals are seen as the sum of several components which can be mixed and matched to order. Take, for example, the role of protein production in current dairy breeding. The price of milk is largely determined by the price of protein, so that dairy breeders wanting to serve their clients' commercial interests focus on increasing the protein content in milk. The effects of this on the animals are unknown.

The DPS index is another example of 'component thinking' as it purports to reflect lifetime production on the basis of a limited number of quantifiable traits, while it is common knowledge that a characteristic like lifetime production depends on innumerable genetic aspects.

A third example: pig breeders have focused for years on producing lean animals with little fat, with no regard for the function of body fat in thermo-regulation. Pig producers have compensated this by building climate-controlled pig houses. The animals have been reduced to food components in the making.

An extreme focus on DNA is responsible for the development of genetic marker technology to enable people to select on specific traits at DNA level. By mapping genes and their associated traits, people will be able to construct complete DNA profiles of animal species and select traits in accordance with their wishes. This would be a direct threat to the animal as an integral living organism. Marker selection can also be used to select important recessive traits. In cattle breeding, for example, blood samples can be taken of innately hornless animals in order to identify the gene pattern that goes with this recessive trait. It will then be possible to select animals on innate hornlessness (Pryce et al., 2001). Obviously, all these applications conflict with organic agriculture's holistic vision on animals and systems.

4.3. Genotype-environment interaction

This brings us to the subject of genotype by environment (GxE) interaction. This subject lies at the root of the question whether animals bred for conventional agriculture are suitable for organic farming. Due to GxE interaction traits can differ so strongly, that we cannot the same traits anymore (see section 2.4). Under the new conditions new traits will appear of which no parameters such as heritability or correlations are known (Olesen et al., 2000). This dynamic process plays an important role in organic agriculture.

In conventional conditions, GxE has a modest effect on production traits. Correlations between milk production in different countries have been calculated between 0.70 and 0.98 (Interbull, 2000; Ten Napel and Van der Werf, 1995). This can be explained by the standardisation of conditions in conventional production.

As yet, there has been no scientific attempt to study the impact of GxE on other 'functional' traits. This also applies for possible GxE differences between conventional and organic production. It is expected that each trait interacts uniquely with environmental conditions. GxE is thought to be smaller for production traits than for functional characteristics such as fertility, susceptibility for mastitis and behaviour.

Obviously, the extend to which environments differ will have an impact on GxE . Each farmer creates his own farm environment, as explained in section 3.4. We might see that GxE plays a smaller role in the more conventional approach to organic production, compared to organic farms organised on agri-ecological principles or the integrity concept.

Farm-specific breeding

The only way to avoid GxE entirely would be to have each farmer establish farm based animal breeding. In this way, each farmer selects automatically animals which are optimally adapted to the specific conditions of the farm, provided of course that these are stable over a longer period of time. In many respects, this breeding method would appear to be ideal for organic systems. After all, it would ensure that animals are adapted to the farm system and that there is diversity within breeds and it can be carried out without resorting to undesirable reproduction and propagation technologies.

Farm-specific breeding however requires specific knowledge. On many farms, there will be practical barriers to on-farm breeding. It could however be a goal or ideal that the organic sector could strive for. In the breeding scenarios in chapter 5 we therefore examine possibilities for approaching this ideal within the constraints of current breeding programmes, which are also starting to take more notice of organic principles and aims.

Nucleus breeding units

Nucleus breeding units are slowly becoming the standard in dairy breeding. These are set up using the best breeding animals available, which are tested and selected in special test stations. At a test station, however, conditions of husbandry and health will always be optimised. This implies, for example, that animals are housed indoors year-round. As the disparity with conditions on commercial farms grows, the less value the selection may have for performance in commercial farm conditions, whether organic or conventional.

In pig and poultry breeding, testing and selection of purebred lines are also carried out in closed nucleus units. Again, there is an enormous disparity between these nucleus units and working (commercial) organic and conventional systems.

4.4. Traits and breeding goals

Until now, we have discussed at length the breeding and selection techniques that are used especially to stimulate or repress certain characteristics. We must also however take a critical look at the characteristics that are selected. Many factors determine which characteristics are considered desirable in livestock, and therefore which goals breeding programmes should pursue. First of all, there is the GxE described above and the personal style of farming. Questions about breeding for the organic sector must therefore always be considered against the background of the more general debate on the course of organic production. Should organic agriculture in Europe take the course of large-scale industrial production, there will only be a few general characteristics to distinguish organic from conventional. Should the sector however decide on a more idealistic, agri-ecological course, which in effect IFOAM calls for in its aims and principles, then GxE will play a larger role and new traits get important.

If the sector decides on the more idealistic course, it is likely that the use of reproduction technologies will be restricted. This alone might be enough to necessitate the establishment of an organic breeding programme distinct from existing programmes. At the same time, demand will grow for traits which suit organic styles of farm management. For example, many farmers with an agri-ecological style of management have noticed that cows with higher milk yields often have more health and fertility problems. The milk type Holstein breed appear to be particularly vulnerable, especially when the cows' diet is low on concentrates and their fodder is grown on sandy or peaty soils. In farmers' words, the cows are too skinny and give away too much of themselves. These problems are not as severe in the pig and poultry sector because the animals' rations contain a higher proportion of concentrates.

The selection of animals for dairy production is commonly based on such general traits as intake of roughage, fertility, health, longevity, good legs, udder health and production. These traits reflect what conventional dairy farmers value in dairy animals. At first glance, they appear to be the same as what organic dairy farmers aim for. The question is, however, how these traits are interpreted for the different conditions and whether they are then still comparable. Production, for example, could be interpreted as production on the basis of roughage or on the basis of a combined diet of roughage and concentrate (see GxE box in chapter 2). Health, too, can be interpreted differently depending on whether the preventive administering of antibiotics is a regular component of livestock management or not. Organic principles and standards result in a different interpretation of these characteristics.

Depending on the farm system used, certain traits may be less important to one system than another. Mastitis, for example, particularly affects high-yielding cows. Organic farmers who elect to limit the yield per cow and to optimise the animals' natural resistance to disease in an extensive husbandry system will find a much lower susceptibility for mastitis in their herd. Susceptibility to mastitis thus becomes less important in the selection. In poultry, cannibalism and feather-pecking occur more frequently in large, exclusively female groups (> 1000 hens). By keeping the hens with roosters in smaller groups, there is less need to take feather-pecking into account in the selection.

These examples illustrate that the goals for organic breeding depend to a large part on the direction that organic production will take in the future. Different streams will each have their own breeding goals.

4.5. Social- economic aspects and diversity

As stated earlier in this report, breeders are rarely motivated by economic objectives alone. Strikwerda describes the often emotional response of many breeders to the mass infiltration of the Holstein breed in the Dutch dairy herd. The chief inspector of the NRS, Klaas Stapel was quoted as saying that "it is unlikely that careful calculations played an important part in the decision to introduce Holstein blood into the herd". This was not a requirement, however, because "breeders have nearly always followed their intuitions to some extent rather than keeping strictly to the line of reason". Breeding is still a matter of the heart, witness the many breeding fairs and competitions for conformation in our country and around the world.

These emotive influences on breeding have a positive effect on diversity. Indeed, the emotive factor is an integral part of the foundation breeding programme for Friesian-Holstein cows in the Netherlands in which eighteen farmers breed unique lines by carrying out their own selection with as little outside interference as possible.

One of organic agriculture's aims is to maintain agricultural diversity. To this end, every livestock farmer should have the freedom and courage to determine the course of development of his own herd. Since World War Two, however, breeding has increasingly become the domain of specialised companies operating on and for a global market (Brascamp, 1998). Breeding companies make the first selection of animals which they bring onto the market. In dairy production, this first selection limits farmers scope for making their own secondary selection (see chapter 2), as all the major traits have already been decided on.

In this way farmers in general just follow the decisions of the breeding companies and take the results for granted. This has resulted the so-called 'Holsteinisation' and the world wide reduction in diversity in dairy stock. occurred to them. This is now leading to the expression of negative traits, such as CVM and BLAD, and a general decline in animal health and fertility (Veeteelt, 2000c).

Pig and poultry breeding are already the exclusive domain of a handful of international concerns. Farmers can only choose from a few hybrids (Hunton, 2001). Breeding companies have thus become almost solely responsible for maintaining the diversity of species and traits within species. This situation is unacceptable to organic and conventional agriculture, as it threatens the existence of many traditional landraces which now need to be protected from extinction.

Research has shown that the increase in inbreeding can be counteracted by using more bulls and spreading their distribution (Meeuwissen and Wooliams, 1994; Bijma, 2000). But would this be enough for organic agriculture? Now that breeding is concentrated within a few multinational companies, the bond that has traditionally existed between breeders and farmers has weakened. Breeding companies must be able to compete on the global market: their primary aim is to sell as much promising breeding stock as they can. Expensive advertisements and special offers on semen ('bull of the month') are used to lure farmers, who have become consumers rather than participants in the breeding process.

The question is whether the organic sector should stay in this economic game, especially because of its negative effect on diversity. Organic farmers could stimulate diversity by choosing their own direction of breeding using different breeds, types or crosses. This would stimulate diversity and ensure the continuation of the old breeds and contribute to the preservation of traditional cultivated landscapes. Within breeds, diversity could be enhanced by stimulating and facilitating farm-specific breeding.

4.6. Generalisation versus differentiation

It will be clear to readers that two opposing forces are at work in breeding: generalisation versus differentiation. Generalisation is associated with cooperation. In order to work together, a shared or general approach is necessary. The largest common denominator determines the breeding goals. The value of the selected breeding goals for specific farm conditions inevitably declines, which translates into a reduced efficiency due to a surmised GxE.

Differentiation means that selection takes place on the basis of individual farm requirements. A limited degree of differentiation can compensate for the disadvantages of generalisation. Extreme differentiation ultimately leads to a unique on-farm selection based on own breeding goals and estimated breeding values.

generalisation / cooperation	differentiation / individual farms
Select a common goal in order to intensify selection; Common EBVs (e.g. progeny study) increases reliability of selection.	Farm-specific selection of breeding bulls; Utilise own performance results.

Generalisation may accelerate genetic progress with respect to the common goal, but it performs less accurately at farm level. Differentiation increases the effectiveness of selections at farm level, but it achieves lower genetic progress at population level.

The two forces can be balanced in a dynamic process (Roep, 2000). It is possible for farmers to achieve such a balance according to the results of a study called *Breeding with style (Stijlvol Fokken)* by Groen et al. (1998), by making their own selection of bulls from breeding companies' to match their own specific style of farm management.

In conventional dairy breeding, differentiation is primarily achieved by the farmer making a selection of female animals from the farm herd and selecting a few breeding bulls from breeding companies' lists. In the scope of this study into organic breeding, we will have to determine whether the specific characteristics of organic agriculture necessitate a greater degree of differentiation in breeding, to be realised perhaps by estimating breeding values specifically for the sector or for individual farms or by selecting different bulls.

4.7. Animal welfare and integrity

Animal welfare and animal integrity are important principles in organic agriculture (IFOAM, 2000). Yet many problems in organic farming practice concern welfare and integrity (Varenkamp and Boons, 1999; Offerhaus et al., 1993; Van Putten, 2000). The issues discussed in this chapter all concern animal welfare and integrity in one way or another. The impact of reproduction technologies on welfare and integrity has already been discussed. We now briefly consider the role of other aspects of breeding: EBVs, GxE, traits and breeding goals, social economic factors, inbreeding and diversity.

Selective breeding based on early maturing animals produces animals which will have shorter lives. A disregard for GxE interaction might produce animals which are less adaptable to organic systems. Allowing inbreeding on a large scale threatens the survival of populations and increases the incidence of deformities / disorders such as BLAD, CVM and infertility. A singular focus on production traits, and thus commercial profit, in the selection process may produce animals with a poor fertility and abnormal behaviour.

Conventional breeders are starting to acknowledge the importance of animal health and welfare (Veerkamp, 1999). The inclusion of health and longevity traits slows down the rate of genetic progress regarding productivity. Conventionally bred animals still have a high genetic disposition for production, however, and it is not certain how easily they would tolerate organic conditions.

5. Possible scenarios for breeding in organic agriculture

In the previous chapters, we described consecutively breeding and organic agriculture and explained the problems that arise from using conventionally bred animals in organic production systems. In this chapter, we give suggestions as to how these difficulties might be resolved, and how organic principles could be taken into account in breeding. In chapter 3, we noted that the organic sector is made up of a diverse group of farmers with different styles of farm management in different stages of development. The scenarios below take this diversity into account. We also consider the possibilities of using established, conventional breeding programmes, also in the light of possible future developments in this sector. The scenarios are described in detail only for the dairy sector, but they are in theory transferable -- with different accents -- to pig and poultry production. These sectors are discussed briefly at the end of the chapter.

5.1. Scenarios for dairy breeding

The main question here is, are current dairy breeding practices -- the whole of breeding goals, breeding techniques and reproduction technologies -- appropriate for organic dairy farming? When individual farmers are asked to describe the traits of an ideal cow, the description given by conventional farmers hardly differs from organic farmers' answer. Ideally, all farmers want cows that give milk generously, easily and trouble-free. The question is how such animals can be obtained. Genotype by environment interactions may cause a trait to perform or be expressed differently in different conditions. How do we deal with this?

In this section, we present a number of possible breeding scenarios for organic dairy farming. The scenarios can be placed consecutively on a continuum from maximum use of conventional, global breeding to farm-specific breeding. We also link these breeding strategies to the different streams in organic production (see figure 5.1). Possibilities and problems will be described per scenario. For each scenario, we put forward propositions for discussion.

5.1.1. The use of conventional breeding schemes

In this scenario, organic farmers continue to make use of conventional breeding and make no demands with respect to taking into account specific organic considerations. Farmers who choose this approach attach a high value to the wide array of animals offered by conventional breeders, which enables them to choose bulls with a high genetic merit for milk production and conformation. They perceive the rate of genetic progress in conventional breeding as high, and want to benefit from this progress. They believe that a high genetic merit for milk production will by definition result in more milk, and do not make exceptions for the organic conditions on their farm. If necessary, they will try to adapt conditions to the suit the animals.

Conventional breeding in the future will be more focused on functional traits for durability and health. The one-sided selection on milk production will decline. Organic dairy farmers who opt to use conventional breeding see this as a positive development. These farmers accept the indirect use of modern reproduction technologies with their negative effects on animal welfare, animal integrity and the naturalness of the biological system.

Propositions:

1. The use of AI in organic farming is allowed indefinitely.

2. Indirect use of ET and other reproduction technologies may continue.

5.1.2. Conventional breeding without ET

In this scenario, farmers continue to benefit from current breeding, on condition that the animals used on their farm are not born from ET. These farmers demand ET-free bulls. Various breeding and AI organisations in the Netherlands still have a number of bulls which were born from natural mating or AI. In 2001, for example, CR-Delta's ET-free stock consisted of 15 black and white HF bulls, 13 red HF bulls and 3 MRIJ bulls. KI-Kampen has 20 black-and-white HF and 6 red HF bulls which are ET-free, as well as 10 FH and 3 MRIJ bulls. Bulls fron other small breeds are often free from ET. Farmers who choose this approach do not object to the smaller selection of bulls and see their choice as an important step towards a more organic approach to selective breeding. They continue to urge breeding organisations to work on a bigger pool of ET-free breeding stock. Rising demand may facilitate AI and breeding organisations to increase their activities in this direction.

Proposition:

1. The direct and indirect use of ET by organic farmers is not allowed.

5.1.3. Conventional breeding adapted to organic agriculture

There are four ways in which this scenario could be worked out:

(1) Lifetime production breeding
Farmers restrict their selection to sires whose mother, mother's mother and father's mother jointly produced at least 150,000 kg milk. In addition to EBVs, they also value data on multiple lactations and lifetime production.

(2) Ecological estimated breeding value
An ecological sum index could be developed composed of traits which are considered important for 'ecological' production (see section 2.5). This index should be developed per country, using for example the German Ökologische Gesamtzuchtwert (ÖGZ) as a blueprint. Farmers have to wait for a few years until a reliable EBV can be determined for a bull, which slows the rate of genetic progress, but they accept this as they still tap into the benefits of conventional breeding.

(3) Taking GxE interaction into account
This type of farmer wants to avoid the GxE interaction effect as much as possible, but is uncertain about the size of this effect. The diversity between organic farms means that the GxE interaction effect will differ per farm. Farmers need more information about conditions at the breeding station, about soil type, housing system, diet and medical regime. EBVs based on daughters' lactations should be given separately for soil type and farm type. These daughter sub-groups will be smaller, and it will take longer until enough information is available for an accurate EBV. This is considered acceptable: for these farmers, the benefits of minimising GxE interaction compensates for the delay.

(4) aAa selection
The aAa system can be used to achieve an optimum balance in cows' conformation, and thus provides important information next to the EBVs. To this end, all bulls earmarked for organic agriculture would be analysed and given an aAa code. Cows, too, would be analysed and coded to find an optimum balance for problem-free production. This would give added value to organic production.

Propositions:

1. The lifetime production of a bull's ancestors is important information for selective breeding.
2. GxE interaction can be avoided by taking into account conditions at the breeders farm.

5.1.4. Breeding based on an organic basis and organic principles

As the organic dairy sector grows, more data on performance in organic conditions becomes available. Currently, there are about 12,000 organic dairy cows in the Netherlands. If this trend continues, it may in the future become feasible to establish a organic based quantitative breeding system.

(1) Organic breeding values
This group of farmers believes that the organic sector as a whole would do well to establish its own selective breeding of organic livestock. They would therefore select bulls from an organic farm whose daughters have also been tested on organic farms. Currently, bulls which meet these criteria are not selected. But farmers who support this approach are keen to participate in the development of such a system provided the job is tackled professionally, i.e. that a 100% organic breeding and AI organisation is established so that a broad selection of bulls will be available in the future. Specifically, these organic farmers see their role as stimulating the supply and testing of bulls from organic farms. Once there is a sufficiently large pool of bulls, they will start using these so that estimated breeding values can be determined.

Currently, accurate breeding values can be determined for a handful of bulls on the basis of the performance of daughters on organic farms. This is not sufficient, however. Moreover, some bulls are no longer commercially available due to the time lag associated with determining organic breeding values. The Government wants the organic sector to grow to 10% of all agricultural production by 2005; if this target is realised there would be about 100,000 organic dairy cows in the Netherlands. This may be a feasible population for quantitative organic breeding.

The Dutch certification company Skal, too, has plans to draw up regulations for organic AI. AI organisations may produce organic bulls themselves or offer their facilities for initiatives by parties in the organic sector.

Propositions:
1. Breeding is only organic if the breeding bulls and their families are kept in organic conditions.
2. Organic agriculture cannot do without 100% organic selective breeding.
3. A smaller selection of sires weighs up against the benefits of 100% organic animal breeding.

5.1.5. Regional breeding

Farmers who support regional breeding do so on principle. They also feel that the interference of environmental factors is minimised in regional breeding. Setting up their own farm-specific breeding programme is not an option, however. Instead, they use bulls from breeders in their region. Cows are served either naturally or through AI. The breeders practice kinbreeding so that animals kept on a certain soil type are optimally adapted to farm-specific conditions. Farmers eventually use bulls from different breeding farms to benefit from the heterosis effect. For this breeding strategy regulations on the marketing of semen must be adapted to that semen can be collected on the breeding farm and sold from there.

Propositions:

1. Breeding for organic agriculture should be the domain of individual breeders.
2. Inbreeding and heterosis are important instruments in selective breeding.

5.1.6. Farm-specific (on-farm) breeding

These farmers choose to set up their own breeding programme so that in the long run their dairy herd will be optimally adapted to the specific conditions on the farm. We call this farm-specific breeding. These farmers each have their own stock of breeding bulls. Cows are served naturally or inseminated artificially with semen which has been collected and frozen by an AI organisation. GxE interaction does not play a role in farm-specific breeding because animals' performance is evaluated under the same conditions. In order to breed successfully in this way, these farmers have specific breeding knowledge and skills. He or she is a 'real breeder'.

Genetic progress with this approach is relatively slow due to the long generation intervals but very effective in order to the adaptation to the farm management. Heifers are usually selected in their first lactation. Bulls cannot be evaluated until they are fully matured. This type of selection necessitates the farmer to keep a large number of youngstock as well as 1 bull per 10 cows in average. Bulls are potentially dangerous animals, and it is absolutely vital that the farmer knows how to handle bulls.

This type of breeding will enhance diversity because, in the end, every breeder has his own vision about the ideal type of cow for production. Every farm would have a unique population of animals.

Propositions

1. Farm-specific breeding is the ideal type of breeding for organic agriculture.
2. AI should be banned in organic agriculture.

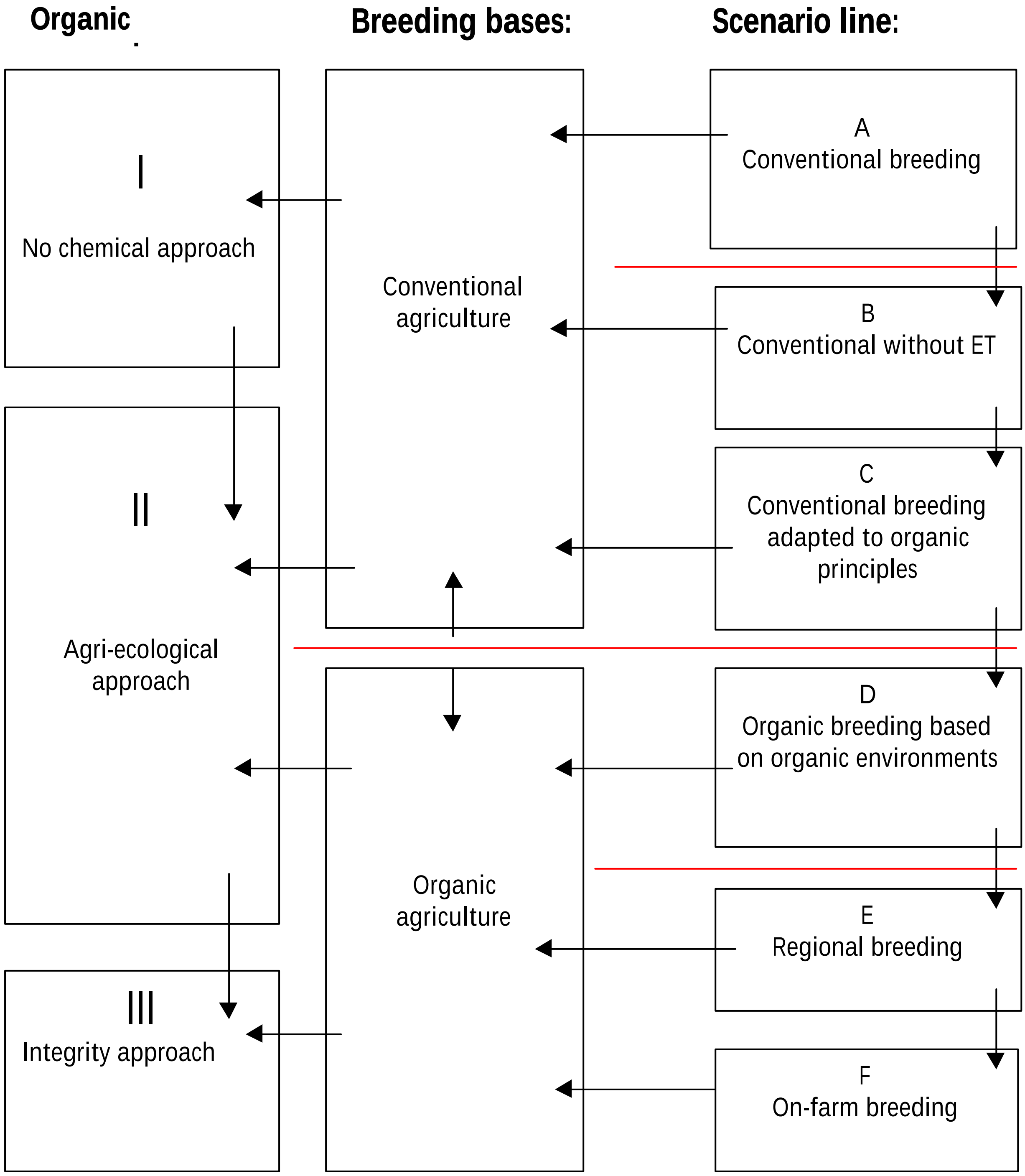
5.2. Breeds and hybrids

All the scenarios above might be carried out with different breeds or hybrids. Organic principles clearly favour the use of local breeds. There are many Dutch dairy breeds, such as FH, MRIJ, Blaarkop, Witrik, Friesian red-and-white and Lakenvelder, which could be used in organic dairy production. At the moment, however, many organic farmers use crosses with Montbéliarde and Brown Swiss to acquire desirable traits. Some farmers plan to replace their herds entirely with one of these breeds. Others want to benefit from the heterosis effect in hybrid animals and use these breeds only for crossing. It should be noted, however, that crosses can also be made with local Dutch breeds.

Proposition:

1. Farmers should stock only local breeds, as this is in keeping with organic principles.

Figure 5.1: Visualisation of possible breeding scenario's next to organic approaches



5.3. Considerations in scenarios for pig breeding

In principle, the main lines of the scenarios sketched above for dairy cattle also apply to pig breeding. Currently, pig producers are completely dependent on animals produced by conventional breeding. A few farmers buy sows from organic propagating units. Organic pig farmers could make a start with organic breeding by trying out one or more alternative breeding strategies with conventional stock. Already, crosses are made especially to produce hardier animals for organic conditions. In the Netherlands, for example, Duroc or Crusta boars are used to this end.

Other countries, however, also have local breeds which would be well-suited to free-range systems. In the UK there is a long tradition of keeping pigs outdoors; several breeds which are adapted to outdoor conditions, for example the Hampshire breed, are readily available in these countries. Also in Germany is more expertise on organic pig production. Interesting breeds are Angler Sattelschwein and Schwabisch-Hällisches Schwein, which have a good roughage uptake (Mathes, 1999). Also in Denmark are free range systems are in use and knowledge about successful breeds is possible available . It is important, therefore, that the Dutch organic pig sector makes an inventory of the breeding stock used in other countries, so that suitable breeds can be crossed with modern hybrids. Scandinavian landrace sows would appear to be particularly suitable for organic production (Slaghuis, oral information) for their good mothering traits and good production of uniform piglets.

A completely organic breeding system for the organic pig sector in the Netherlands might not be feasible. An effective breeding programme, without any deterioration in technical results, could be realised with only 3000 sows producing 60,000 porkers per year. At this time, however, there are too few organic pig farms and the number of porkers slaughtered per year (19,000) is too small. A covenant agreement to stimulate organic pig production was signed by the government and representatives from the sector in 2000, and aims for 100,000 organic porkers per year. With those numbers, an organic breeding programme would be feasible.

Farm-specific breeding is possible in pig production. It would reduce farmers' dependence on breeding companies and enhance diversity. But, at least in the Netherlands, it would also require farmers to take a pretty drastic step away from the current status quo. A lot will depend on future developments in organic and conventional pig production. Farm-specific breeding could be feasible for large units. But it is possible that the sector will move away from specialisation, and that pigs will be returned to their more traditional setting on mixed farms where they are kept in smaller groups. In that case, farm-specific breeding would be difficult. Perhaps these farms, with their smaller populations, could source animals from larger, specialised organic pig production units.

5.4. Considerations in scenarios for poultry breeding

Again, poultry breeding scenarios largely overlap the scenarios described in detail for dairy breeding. Dutch poultry, both layers and broilers, are hybrids or brands produced by conventional breeding companies. Propagation largely takes place in conventional conditions, although the rearing of layers must take place in organic units.

A more organic breeding system would initially depend on the cooperation of the multinational breeding companies that currently dominate the sector in order to ensure a reasonable level of production. These breeding companies are focusing more strongly on producing hybrids for free-range systems. This is a significant development for the organic sector.

Whether or not alternative systems will develop will also depend on the respective courses that conventional breeding and organic poultry farming will take in the future. Organic agriculture may benefit from the increased selection of free-range poultry, but other developments in the breeding sector such as marker selection and genetic modification conflict with organic principles and may force a break between organic production and conventional breeding in the future.

Developments within the organic sector, too, might necessitate an alternative breeding approach. Dual-purpose poultry production which avoids the problem of killing young cockerels might well take hold in the organic sector, raising the demand for dual-purpose poultry. Another trend might be to extend layers' productive life by keeping them on during the moulting season. Suitable animals for these types of production systems are available outside the Netherlands. For example, the dual-purpose hybrid Tetra Zweinutz in Germany. The Dutch organic poultry sector should explore the possibilities available outside the Netherlands. In particular, many initiatives are being undertaken in Germany to produce dual-purpose poultry and hybrids for organic production.

Farm-specific breeding would not appear to be an option for poultry production right now, but it is not impossible. There is one farm in the Netherlands where about 200 hens are kept for selection. Selected hens hatch their own eggs. This approach might not be feasible or professional enough for large production units. It depends largely on the situation and possibilities of a farm and the will of the farmer. Another consideration in farm-specific breeding is whether eggs should be incubated or hatched naturally by the hen. Important factors are the hen's brooding characteristics and the scale of hatching required. Incubators can handle larger quantities of eggs.

Similar possibilities exist for the broiler sector. Many broiler brands are currently produced by ISA. These hybrids are suitable for the longer finishing time in organic poultry production. The advantage of using dual-purpose layers is that young cockerels are not wasted. Meat production again becomes a by-product of egg production. The mother hen used by ISA is a dual-purpose hen which is used in France.

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Appendixes

Appendix I : IFOAM, 2000

Appendix II: Description of reproduction technologies

Appendix III: Inbreeding level Rivelino 279

Appendix IV : Ökologische Gezamptzuchtwerd

Appendix I: The Principle Aims of Organic Production and Processing

(Source IFOAM website, 2001)

Organic Production and Processing is based on a number of principles and ideas. They are all important and are not necessarily listed here in order of importance.

1. To produce food of high quality in sufficient quantity.
2. To interact in a constructive and life-enhancing way with natural systems and cycles.
3. To consider the wider social and ecological impact of the organic production and processing system.
4. To encourage and enhance biological cycles within the farming system, involving micro-organisms, soil flora and fauna, plants and animals.
5. To develop a valuable and sustainable aquatic ecosystem.
6. To maintain and increase long term fertility of soils.
7. To maintain the genetic diversity of the production system and its surroundings, including the protection of plant and wildlife habitats.
8. To promote the healthy use and proper care of water, water resources and all life therein.
9. To use, as far as possible, renewable resources in locally organised production systems.
10. To create a harmonious balance between crop production and animal husbandry.
11. To give all livestock conditions of life with due consideration for the basic aspects of their innate behaviour.
12. To minimise all forms of pollution.
13. To process organic products using renewable resources.
14. To produce fully biodegradable organic products.
15. To produce textiles which are long-lasting and of good quality.
16. To allow everyone involved in organic production and processing a quality of life which meets their basic needs and allows an adequate return and satisfaction from their work, including a safe working environment.
17. To progress toward an entire production, processing and distribution chain which is both socially just and ecologically responsible.

Animal Husbandry Management

General Principles

Management techniques in animal husbandry should be governed by the physiological and ethological needs of the farm animals in question. This includes:

- That animals should be allowed to conduct their basic behavioural needs.
- That all management techniques, including those where production levels and speed of growth are concerned, should be directed to the good health and welfare of the animals.

The certification body / standardising organisation shall ensure that the management of the animal environment takes into account the behavioural needs of the animals and provides for:

a. Sufficient free movement

b. Sufficient fresh air and natural daylight according to the needs of the animals

c. Protection against excessive sunlight, temperatures, rain and wind according to the needs of the animals

d. Enough lying and / or resting area according to the needs of the animal. For all animals

requiring bedding, natural materials shall be provided.

e. Ample access to fresh water and feed according to the needs of the animals

f. Adequate facilities for expressing behaviour in accordance with the biological and

ethological needs of the species.

g. No construction materials or production equipment shall be used in a way that may

significantly harm human or animal health.

h. Poultry, rabbits and pigs shall not be kept in cages.

All animals shall have access to open air and / or grazing appropriate to the type of animal and season taking into account their age and condition, to be specified by the certification body / standardising organisation.

Landless animal husbandry systems shall not be allowed

Herd animals shall not be kept individually.

5.3. Brought-in Animals

General Principles

All organic animals should be born and raised on the organic holding.

Recommendations

Organic animal husbandry should not be dependent on conventional raising systems. When trading or exchanging livestock, this should preferably take place between organic farms or as part of a long term co-operation between specific farms.

When organic livestock is not available, the certification body / standardising organisation may allow brought-in conventional animals according to the following age limits:

a. 2 day old chickens for meat production

b. 18 week old hens for egg production

c. 2 week old for any other poultry

d. piglets up to six weeks and after weaning

e. calves up to 4 weeks old which have received colostrum and are fed a diet consisting mainly of full milk.

Certification bodies / standardising organisations shall set time limits (which in

any event shall be before 31st December 2003) for implementation of certified organic animals from conception for each type of animal.

Breeding stock may be brought in from conventional farms with a yearly maximum of 10% of the adult animals of the same species on the farm.For brought-in breeding stock the certification body / standardising organisation may allow a higher yearly maximum than 10% in the following cases and with specific time limits:

a. Unforeseen severe natural or man made events

b. Considerable enlargement of the farm

c. Establishment of a new type of animal production on the farm

d. Small holdings

Breeds and Breeding

Breeds should be chosen which are adapted to local conditions.Breeding goals should not be in opposition to the animals' natural behaviour and should be directed toward good health.Breeding should not include methods that make the farming system dependent on high technological and capital intensive methods. Reproduction techniques should be natural.

The certification body / standardising organisation shall ensure that breeding systems are based on breeds that can both copulate and give birth naturally.

Artificial insemination is allowed.

Embryo transfer techniques are not allowed.

Hormonal heat treatment and induced birth are not allowed unless applied to individual animals for medical reasons and under veterinary advice.

The use of genetically engineered species or breeds is not allowed.

Mutilations

The animals distinctive characteristics should be respected. Species should be chosen which do not require mutilation.Exceptions for mutilations should only be given when suffering can be kept to the minimum.

Mutilations are not allowed.

The certification body / standardising organisation may allow the following exceptions:Castrations, Tail docking of lambs ,Dehorning ,Ringing ,Mulesing

Suffering shall be minimised and anaesthetics used where appropriate.

Appendix II: Reproduction technologies

AI

Artificial insemination means that a cow is inseminated with a pipetteful of semen. Semen is collected and stored at AI stations. Collected semen is dilated, so that several hundred doses can be made. Semen is stored in straws which are kept in liquid nitrogen at a temperature of -196 ^{0}C. In theory, frozen semen can be stored indefinitely. Thirty to forty per cent of sperm cells die during the freezing and thawing process. For a satisfactory fertility rate, i.e. 70% non-return after 56 days, a dose of semen must contain ten to twenty million sperm cells. There is some variation, however, per bull (Den Daas and Wagtendonk, 1993).

Boars' semen is also collected and dilated, but it is not frozen. It is stored in a cool place and must be used within three days of collection. Current freezing methods kill too many sperm cells. Boar semen is frozen for the genetic databank.

ET

ET involves transferring one or more embryos from a donor to one of more recipient cows. The surgical removal of embryos is not possible with cows. Instead, a catheter is inserted into the uterus, through which a saline solution is injected to flush the embryos out. In pigs, this method only works if the size of the uterus has been surgically reduced. Otherwise, embryos can only be obtained by slaughtering the sow.

In vivo developed embryos are flushed in the morula or blastocyst stage, before they attach to the uterus lining. Bovine embryos in these stages of development respond well to deep-freezing and can be stored in liquid nitrogen. This technique has not been perfected in pig breeding, but the results of the 'pull straw system', in which embryos are frozen in one step, are promising (ref.).

Fresh or thawed embryos are transplanted into the recipient's uterus with a special pipette. The technique is non-surgical. In cows, ET has a fertility rate of about 60%. The technology is still being refined for pig breeding.

IVP

In vitro production or IVP is actually a combination of ovum pick-up (OPU), in vitro fertilisation (IVF) and embryo culture technology (IVC). OPU is a surgical technique. The cow is given a local anesthetic. A needle is inserted into the vagina and punctures the vagina wall. The needle is guided to the ovary by the veterinarian's other hand in the cow's rectum. The ova are aspirated from the ovary follicles and collected. This operation lasts twenty to thirty minutes and is usually carried out twice a week.

The ova are cultured in vitro for 24 hours and then fertilised in vitro with thawed semen. The fertilised ova are cultured for five to six days to the morula or blastocyst stage. When they are then transplanted into recipients, the fertility rate is usually 50 to 60%. If the embryos are frozen first, the success rate drops to about 40%. IVP yields about 5 to 7 transferable embryos per donor cow per week.

This technology is not yet refined for practical use in pig breeding. Ova can only be collected surgically or after slaughtering the sow. In vitro fertilisation often results in polyspermy

Superovulation

Embryo transfer is sometimes used after a natural ovulation. More often, however, it is combined with superovulation to improve the efficiency of the operation. A donor cow is given follicle stimulating hormone (FSH) prior to ovulation, so that multiple ovulation takes place. After ovulation, the cow is inseminated two or three times to fertilise as many ova as possible. Fertilised ova develop to the transferable stage during their five to six day journey down the oviduct. Once in the uterus, they are flushed out. Using MOET, about seven viable embryos are produced about every six weeks, resulting in three to four pregnancies.

Appendix III: Low inbreeding of Rivelino 279 in an on-farm family breeding scheme of 25 years

Rivelino 279 (fokker Endendijk, Ermelo)	Rivelino 235	Rivelino 191	Rivelino 146	Rivelino 37	Rivella 24	vaderlijn in 3 generaties terug op Blitsard Kleine
					Elkske 19	vader Rivella 69 voert terug op Adema-bloed
				Kate 153	Rivelino 53	vaderlijn Andries-Wijke's Keimpe-Blitsard Keimpe
					Kate 142	vader Rivella 24 - zie boven; moeder Kate 74 voert terug op Bl. Setske's Keimpe
			Kate 177	Klooster Synaeda A	- Constant - Bl. Setske's Keimpe	
				Kate 158	Rivelino 57	voer via vader en moeder terug op Rivella 24 - zie boven
					Kate 148	dochter Andries (zie boven), via moeder dubbel op Rivella 24 (zie boven)
		Nelly 59	Rivella 24	Rivella 7	Blitsard Jakson	zoon Blitsard Kleine
					Kate 65a	dochter Adema 433
				Kate 83	Jantje's Takomst	zoon Blitsard Sietse
					kleindochter Blitsard Klein	
			Nelle 56	Wijke's Keimpe	zoon Blitsard Keimpe wiens moeder een halfzus is van Blitsard Kleine	
				Nelly 34	dochter Adema 729, zoon van Blitsard Keimpe	
	Sjoukje 197	Rivella 147	Rivella 122	Rivella 88	Bl. Setske's Keimpe, zoon van Blitsard Keimpe	
					Kate 108	vader Nammele heeft dubbel Adema bloed
				Jantje 11	Rivella 7	zie boven
					Jantje 8	vader is Blitsard Jet Adema (zoon Anna's Adema) ook de vader van Bl. Keimpe
			Kate 281	Rivella 111	Rivella 88	zoon Bl. Setske's Keimpe - zie boven
					Kate 108	zie boven
				Kate 200	Rivella 84	zoon Bl. Setske's Keimpe - zie boven
					Kate 159	via meerdere lijnen terug op Anna's Adema
			Rivelino 57	Rivelino 38	Rivelino 9	vader is Rivella 24 - zie boven
					Sjoukje 159	vader is Rivella 24 - zie boven
				Kate 140	Rivella 24	zie boven
					Kate 75	voert meermalen terug op Adema en Blitsard Kleine bloed

Appendix IV: Ecological total index (Gunther Postler)

Milkproduction:

Information	Part of the index	
100 days production	6%	20%
101-200	7%	
201-305	7%	
2de lactation		30%
3de lactation		50%

Persistence and gain in production per lactation

Information	Part in index:
Persistence 2 (2de part of 1ste lactation)	20%
Persistence 3 (3de part of 1ste lactation)	40%
Gain in production 2de lact. 1ste lact.	20%
Gain in production 3de lact. t.o.v. 2de lact.	20%

Gebruiksduur Vader en Moeder

Vader	VV: 7%
	VM: 13%
Moeder	MV: 10%
	MM: 16%

Afkalven en Vitaliteit

Afkalfverloop paternaal (vader kalf)	5%
Doodgeboorten paternaal	5%
Afkalfverloop maternaal (vader koe)	15%
Doodgeboorten maternaal	15%
Vruchtbaarheid maternaal	20%
Celgetal melk	20%
Gebruiksduur 48 maanden	20%

Vorm en uier

Relatieve fokwaarde “vorm”	25%
Re. Fokw. Klauwenstand	10%
Afvoer wegens klauwen en benen	10%
Rel. fokw. Uier “sitz”	20%
Rel. fokw. “Strichausbildung”	5%
Rel. fokw. “Strichstellung”	10%
Melkbaarheid	20%