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Genetics and welfare in organic poultry production

A discussion on the suitability of available breeds and hybrids

Brunberg, E.I., Grøva, L. & Serikstad, G.L.
Bioforsk Organic food and farming

www.bioforsk.no

Hovedkontor/Head office
Frederik A. Dahls vei 20
N-1430 Ås
Tel.: (+47) 40 60 41 00
post@bioforsk.no

Bioforsk Organic food and farming
Gunnars veg 6
6630 Tingvoll
Tel.: (+47) 40 60 41 00
Emma.Brunberg@bioforsk.no

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Forfatter(e)/Author(s):

Brunberg, E., Grøva, L. & Serikstad, G.L.

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Sammendrag:

Økologisk produksjon av egg, kylling- og kalkunkjøtt er regulert av internasjonale og nasjonale regler og er annerledes enn tilsvarende konvensjonell produksjon. Raser og hybrider foredlet fram for bruk i konvensjonell produksjon brukes også i økologisk produksjon. Mange egenskaper som er viktig for husdyrvelferd blir påvirket både av miljø og av genetiske egenskaper. Rapporten gir en oversikt over forskning om hvordan dyr med forskjellig genetisk opphav kan være mer eller mindre tilpasset alternative produksjonssystemer. Svarene fra en spørreundersøkelse blant norske fjørfeprodusenter er presentert i rapporten, og til slutt diskuteres ulike løsninger for å oppnå økologisk fjørfeproduksjon med dyrematerialе bedre tilpasset målene og regelverket for økologisk produksjon. Utredningen er utført på oppdrag fra Mattilsynet, via Regelverksutvalget for Økologisk produksjon og forbruk.

Summary:

Organic production of eggs, broilers and turkey is regulated by international and national regulations and differs from conventional production. Breeds and hybrids selected for conventional production are also used in organic production. Many traits that are important for animal welfare are affected both by environment and genetics. This report gives an overview of the research about how animals with different genetics can be more or less suitable for alternative production systems. Moreover, the answers from a questionnaire among Norwegian poultry producers are reported. Possibilities for the development of animals more suitable for the goals and regulations in organic production are discussed.

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	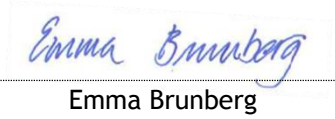
Atle Wibe	Emma Brunberg

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1. Foreword

Having suitable breeds and hybrids available for organic poultry production in Norway is important in order for this production to develop and increase. Bioforsk Organic Food and Farming Division was invited by the Norwegian Food Safety Authority to discuss the suitability of available breeds and hybrids for Norwegian organic poultry production.

We find that this topic is of great importance in order to ensure the high welfare standards and sustainability that are explicit aims in organic poultry production. The work has been conducted as a literature review and a web-based questionnaire to organic poultry producers.

We would like to thank the Norwegian Food Safety Authority for the opportunity to discuss this important topic. Further we would like to thank everyone who has contributed to this study; amongst others organic poultry producers answering the questionnaire, Pål Grønbeck (Norsk fjørfelag), Åsa Odelros AB and other industry partners.

Emma Brunberg | Lise Grøva | Grete Lene Serikstad

2. Norsk sammendrag

I tråd med regelverket er fjørfehold i økologisk landbruk annerledes enn fjørfeholdet i konvensjonelt landbruk. Denne utredningen belyser spørsmålet om det er behov for andre raser til økologisk produksjon av egg, kyllingkjøtt og kalkun enn det som nyttes i dagens økologiske produksjon. Rapporten omfatter en oversikt over relevant litteratur og svarene fra en spørreundersøkelse som ble gjennomført blant norske, økologiske fjørfeprodusenter. Regelverksutvalget for økologisk produksjon har tatt initiativet til arbeidet og Mattilsynet har delfinansiert utredningen via dette utvalget.

Det er flere sider av økologisk produksjon av egg, kylling- og kalkunkjøtt som er annerledes enn tilsvarende konvensjonell produksjon, både mht. fôr, bygninger, medisinering og utegang. Regelverket gir dyra bedre mulighet til å utøve naturlig adferd. Samtidig kan det også bety at dyra får et noe mer ustabilt miljø og at det gir produsentene større utfordringer. Dyras egenskaper er viktige både for produksjon og dyrevelferd i de ulike produksjonssystemene. Det er velkjent at mange egenskaper som er viktig for husdyrvelferd blir påvirket både av miljø og av genetiske egenskaper. Dette kan bety at raser og hybrider med forskjellig genetisk materiale kan være mer eller mindre tilpasset alternative produksjonssystemer.

Litteraturoversikten viser at det er forskjell på ulike raser/hybrider med hensyn til oppførsel, effektivitet av fôropptaket, helse og produksjon. Mye tyder på at det er sammenheng mellom genotype og miljø, noe som betyr at noen genotyper vil være bedre egnet enn andre til økologisk drift.

Det ble sendt ut spørreskjema til 37 økologiske eggprodusenter, 3 produsenter av kyllingkjøtt og til en produsent av økologiske kalkuner. Blant de 16 eggprodusentene som svarte var Lohmann den vanligst hybriden, fulgt av noen få produsenter som nytter Dekalb. I gjennomsnitt vurderte produsentene den hybriden som de brukte til 3,75, på en skala fra 1 til 5 for tilfredshet, hvor 1 var «ikke tilfreds» og 5 var «svært tilfreds». De vurderte det genetiske materialet for fjørfe i Norge generelt til 3,50. Bare noen få produsenter hadde planer om å bytte til en annen rase/hybrid i løpet av de neste årene. To av disse vurderte å prøve Dekalb. Produsentene vurderte muligheten til å velge den genotypen de ønsket som liten, i snitt til 2,5. Mange av respondentene synes det er viktig å kunne velge dyr som er spesielt avlet for økologisk produksjon. Etter deres mening er høy produksjon, rolige og robuste dyr av spesiell interesse for økologisk produksjon.

De tre kyllingprodusentene bruker alle kyllinger av den sentvoksende linjen Ross Rowan. De vurderte den til 3 med hensyn til egnethet for egen produksjon, med kommentar om at også denne rasen vokser for fort. To av de tre mener det er veldig viktig å kunne velge en rase som er avlet for økologisk produksjon og viktige egenskaper for dette er f.eks god og naturlig vekst og rolige dyr med god helse. Både for eggleggende høner og kyllinger ble det påpekt at det var for lite raser/hybrider å velge mellom. Mange av dem som svarte mente at de brukte det best mulige som finnes i Norge per i dag.

Ut fra arbeidet som er utført, er det tydelig at det vil være klare fordeler med å benytte dyr som er selektert for økologisk produksjon. For at dette skal være mulig er det nødvendig med mer forskning og avlsarbeid. Det er også utfordringer knyttet til hvordan kommersiell fjørfeavl er organisert, siden utvalgsarbeidet foregår i utlandet. Nordisk og internasjonalt samarbeid er nødvendig innen forskning, rådgivning og avlsarbeid for å kunne utvikle økologisk fjørfeproduksjon best mulig.

3. English summary

The aim of this report is to investigate if the commercial hybrids available for organic production of eggs, broilers and turkey in Norway are suitable for the organic regulations or if there is a need for birds with different genetics. The report consists of one section with a review of relevant literature within the area and another section in which we report the answers from a questionnaire to Norwegian organic poultry farmers.

Organic production of eggs, broilers and turkey is in many ways rather different from conventional production. The regulations offer the animals greater opportunities to perform natural behaviour but may also offer a slightly more unstable environment and thereby increased challenges for the farmer. It is therefore relevant to believe that different properties of the animals are important for both production and animal welfare in the different production systems. It is well known that many traits important for animal welfare are affected not only by the environment, but also by the genetic makeup of the animal. Since different breeds and hybrids have different genetic makeup, it may be that some are more suitable for alternative production systems than others.

The literature study show that there are differences between breeds/hybrids regarding behaviour, feed efficiency, health and production. Moreover, it seems to be interactions between genotype and environment, e.g. the different genotypes seems to be more suitable for organic production.

The questionnaire was sent to 37 organic egg producers, 3 broiler producers and one farmer producing organic turkeys. Among the 16 responding egg producers the most commonly used hybrid was Lohmann, followed by a few producers using Dekalb. On average, they rated the hybrid they used in their own production as 3.75 (using a scale from 1 to 5, where 1 was not satisfied at all and 5 very satisfied) and the genetic material in Norway rated on average 3.50. Only a few of the producers had plans to change to another genotype within a few years and two of those wanted to try out Dekalb. The freedom to choose the animals they would like to use in the production was rated lower, on average 2.5. Many of the respondents think it is important to be able to choose animals that are especially selected for organic production and suggested that properties like high production, calm behaviour and robust animals are of special importance for organic production.

The three broiler producers all use the slow growing Ross Rowan in their production and graded it with a 3 regarding satisfaction for their own production, with the comment that it still was growing too fast. Two of the three respondents think it was very important to be able to choose a bird that is selected for organic production and important traits were for example a good, but natural, growth, calm behaviour and health traits. For both layers and broilers, it was commented that it was too few genotypes to choose among and many of the respondents say that they used the best alternative there is in Norway today.

In conclusion, we see clear benefits by using birds selected for organic production. Although, to be able to exploit such benefits, more research is needed. There are also challenges with how the commercial breeding for poultry is organised today, since the selection work is performed outside Norway. Nordic and international collaboration on research and advise is probably important for an even more successful production of organic poultry based products.

4. Aim and introduction

The aim of this report is to investigate the suitability of breeds and hybrids available for organic poultry farming (eggs, broilers and turkey) in Norway. In this report, we discuss if there is a need and potential for having other genetic material. The report is divided into two main sections: First, a literature review on the contribution of genetics to animal welfare and production in organic poultry farming. Unfortunately, there is limited literature on organic turkey production. Therefore, this section is limited to layers and broilers. In the second part of the report, we present the results from a small survey among organic poultry producers in Norway on their opinion of the adequacy of the breeds and hybrids available in Norway today.

The regulation for organic animal production clearly states that when choosing breed/strain, these should be able to adapt to local conditions and be robust in order to prevent disease. The use of breeds and hybrids that are adapted to the production system we provide, is important for both animal welfare and production economy. Organic production of eggs, broilers and turkeys is in many ways different compared to conventional production. This implies that the animals selected and available for conventional farming may not necessarily be well suited for organic farming. Organic production systems for poultry can still be regarded as being in a developmental phase regarding regulations, research and problem solving. Different production systems may also require different animal traits, e.g. genes that are beneficial in one production system may not be beneficial in another.

5. Production of organic poultry in Norway

Organic animal production is in general a small proportion of the animal production in Norway. In 2012, organic egg production was the largest of the three poultry based productions consisting of 3.8% of the total number of laying hens in Norway. For poultry meat, only 0.05% of the broilers were organic. There is only one producer of organic turkey meat and the production constituted 0.9% of the total turkey meat production (Norwegian Agricultural Authority, 2013).

International breeding companies supply the genetic material available for commercial poultry production in Norway. Hence, only a few breeding companies perform the genetic selection. For egg production, the grandparent generation of laying hens is imported to Norway from these international breeding companies. These birds are used to breed the parent generation of layers, which are held by a few producers selling layers to farmers producing both conventional and organic eggs. There are two importers in Norway that import four different hybrids: Lohmann LSL, Lohmann LB, ISA Brown and Dekalb white (Grønbeck, P., Norsk fjørfelag, Pers. Comm. 12th of November 2013).

Broilers have a similar production chain as for layers, with the exception that Norway does not have a national stock of the grandparent generation. Instead, the parent generation is imported from a producer in Sweden, which imports the grandparent generation from international companies. The hybrids are either Ross 308, Cobb 500 or the slower growing Ross Rowan (Grønbeck, P., Norsk fjørfelag, Pers. Comm. 12th of November 2013).

5.1 Regulations

The EU regulations (and hence also the Norwegian regulations) on how to produce certified organic animal products affects the animals directly in three main areas (Boelling et al., 2003):

1. Housing – for example access to free-range/grazing
2. Feed – for example the proportion of organically produced feed and roughage
3. Medical care – for example the ban on prophylaxis and extended withholding periods

The regulations are based on the organic principles: Health, ecology, fairness and care (IFOAM http://infohub.ifoam.org/home). To ensure high standards of animal welfare, the regulations emphasize preventive measures for good health, increased space, access to outdoor areas and increased possibilities for performing natural behaviour (e.g. Lund, 2006; Sundrum, 2001). However, some of the regulations make the conditions for organically raised farm animals less controlled and perhaps more challenging compared to the conditions in conventional production (Boelling et al., 2003). For example, access to outdoor areas exposes the animals to different weather conditions and organically produced feed may be a challenge when aiming to fulfill some of the nutrient needs. Not only may this be a challenge for the farmer, but the animals also need to be adapted to an organic farming system. The detailed regulations can be found in Council regulation (EEC) No 2092/91 and Veileder til forskrift om økologisk produksjon og merking av økologiske landbruksprodukter og næringsmidler (Norwegian Food Safety Authority). Relevant regulations for organic poultry production are summarised in the following section.

5.1.1 Housing conditions, feed and medical treatments

Regarding housing conditions, the most obvious difference is that poultry in organic production must have access to an outdoor area. The access to this area should be given when the weather conditions allow it and at least for one third of the life of the bird. The outdoor area should be 4 m^2/laying hen or slaughter chicken and 10 m^2/turkey. Moreover, it is not allowed to keep the birds in cages and the flock size is limited to 3000 layers, 4800 chickens, and 2500 turkeys. In conventional production, no such limits to flock size are given. Regarding indoor area, the maximum animal density is 6 laying hens/m^2 (compared to 9 hens/m^2 in conventional production). For all poultry aimed for slaughter, a maximum weight of 21 kg/m^2 is allowed (compared to 36 kg/m^2 in conventional production). Further, there must be natural light in the house. Organic laying hens also have more perches per hen (18 vs 15 cm per hen). Nests and possibility to dustbath should be available for organic as well as conventional layers.

All feed should be organic and no synthetic amino acids may be given. They should also have access to roughage during day time.

For all organic productions, good health should be maintained, preferably with preventive measures through the choice of breed, good management, feed and flock sizes. It is not allowed to use synthetic medication for preventive treatments, except from vaccination and treatment against parasites if needed. The withdrawal period for medications is twice the withdrawal period for medicines given to animals in conventional production.

5.1.2 The choice of animals

In the EU regulations, it is stated that “In the choice of breeds or strains, account must be taken of the capacity of animals to adapt to local conditions; their vitality, and their resistance to disease. In addition, breeds or strains of animals shall be selected to avoid specific diseases or health problems associated with some breeds or strains used in intensive production. Preference is to be given to indigenous breeds and strains” (Council regulation (EEC) No 2092/91).

There are also minimum slaughter ages for organically kept poultry: 81 days for chickens and 140 days for turkeys. If the producers do not apply to these minimum slaughter ages, slow-growing strains must be used. This means that in practice, slow growing strains of slaughter chickens are used, since commercial broilers grow too fast to be kept until 81 days. The hybrid Ross Rowan is approved as slow growing in Norway. Since there are no organic breeders of organic chickens in Norway, the farmers also need to take the conversion time of 10 weeks into account. Therefore, the slow growing birds need to be kept for at least 10 weeks.

6. Animal welfare and production – current situation and genetics

The animal welfare situation does not only depend on the environment and management of the animals. The individuals themselves (i.e. their genetic makeup) have an influence on several traits affecting the welfare of the flock. In order to draw any conclusions on the adequacy of available animal material in organic farming, current animal welfare challenges must be identified. These can either be unique to the organic production, the same as for conventional production or appear in both production systems but at different frequencies.

Unfortunately, not many studies regarding animal welfare within organic production have been performed in Norway. Some studies are performed in other countries, but it is stated in papers that studies on this subject is lacking, especially regarding poultry and pigs (Lund & Algers, 2003). In addition, there are limits to the applicability of conclusions drawn from studies performed in other countries (perhaps with the exception of the other Nordic countries), since the prerequisites for both organic and conventional production may be different in different countries. However, some general conclusions may be drawn and must be used when discussing the situation in Norway.

Today we know that most complex traits are governed by both environment and genes. The animals used in poultry production are mainly selected for high growth/laying capacity in conventional production environments with barren environments, small opportunities to move and certain group sizes. It is debated whether these animals are suitable for less intensive production systems. It is reasonable to believe that different individual characteristics and genetic make-up are profitable in different environments. Hence, they contribute to how animals cope in certain environments. When certain genes are differently beneficial in different environments, it is said to be a genotype by environment interaction (GxE). The result of a significant GxE interaction can be that for example a sire with a high breeding value in one environment, may have a lower breeding value in another environment. This can have large economic consequences for the farmer.

It is clearly stated in the regulations for organic production that breed and genetics should be taken into account. It is also stated that local breeds are preferred when possible. For commercial poultry production, only a few international breeding companies perform the selection work for both organic and conventional production (Leenstra et al., 2011). It may be that not all breeds (or individuals) are well adapted to organic conditions. One example given by Branciari et al. (2009) is the modern broilers that grow very fast and that not at all benefit from the extensive space allowance in organic poultry production.

In the following sections, we will review some of the research regarding how genetics may influence both production and animal welfare in organic production. Some considerations should be kept in mind while reading the text. First, any breed differences found may not be absolute. The generation interval in poultry is short and the international breeding companies constantly develop their breeding programs. This means that traits of a certain breed may change rather quickly. Moreover, the conditions during which these studies were performed may be very different from the Norwegian production conditions.

6.1 Mortality and health

The organic regulations express that good health among the animals should be maintained mainly by environment, feed and choosing robust breeds. Both loose housing systems and the outdoor environment may pose new health challenges as opposed to production in cages.

6.1.1 Laying hens

For layers, Leenstra et al. (2012) concluded that production was lower and mortality higher in organic flocks compared to free range systems. Figures in such studies may however not be completely comparable to the Norwegian situation. For example, some of the hens are considered to die from cannibalism, and in Europe it is said that this is much more common in organic flocks where beak trimming is prohibited, as opposed to in conventional flocks (Zeltner & Maurer 2009). However, in Norway beak trimming is not allowed in any production system and therefore, the Norwegian farmers are probably already used to prevent cannibalism in other ways than beak trimming.

In our questionnaire (presented later in this report), 13 egg producers gave mortality rates between 0 and 8% (average 3.95%). This could be compared to the mortality rates reported in Norturas report "Kjøttets tilstand" which is 2.8% in cages and 5.0% in loose housing systems. In Sweden, a small survey was performed among 47 egg producers and the mortality in organic production was 11% (4.4-23%) compared to 6% (2.4-11.4%) in other loose systems and 4.9% in cages (Hermansson & Odelros et al., 2010). Only six organic farmers participated in this survey and hence they are not necessarily representative. It is estimated that the mortality in organic egg production in Sweden is 5-6% (Odelros, Å., personal communication). Leenstra et al. (2012) asked farmers producing organic eggs about which traits they regarded the most important for their animals, and mortality was considered the most important factor.

Given the differences in the regulations between organic and conventional production, as referred to in section 5, health problems may be different depending on the production system. One difference is for example that organically held poultry have more space and the possibility to go outside. This gives the animals possibilities to perform more natural behaviour and move more, which generally should be positive for the health. The outdoor system also gives challenges. It is shown in many studies that different parasites are more common in free range systems compared to cages (see for example Berg, 2001 for a review). However, it is discussed whether this has a large influence on animal health and welfare or not. Pasture based systems also give an increased risk for bacterial infections, such as *Campylobacter* and *Salmonella* (Berg, 2001). In a small Swedish survey, two out of six organic poultry flocks had any disease: one with *Salmonella* and one with *E. coli*. This should be seen in comparison with loose housing systems in which 6 out of 25 (all six were aviary systems) had an outbreak of disease (Hermansson & Odelros, 2011).

Leenstra et al. (2012) performed a study within the international EU project "LowInput Breeds". They compared production, health and mortality in different genotypes (white, brown, silver) in different production systems (free range and organic) in different countries (Switzerland, France and The Netherlands). The results indicate differences between genotypes regarding mortality with the silver hens having the highest mortality. Also Mahboub et al. (2004) showed differences between brown and white layers regarding immune traits and Mugnai et al. (2011) indicated a GxE interaction for immune traits. Also Kjaer & Sørensen (2002) compared behaviour and mortality in four different breeds/breed combinations under organic conditions with/without access to extra amino acids. The ISA genotype (selected for high production in cages) had significantly more damages due to pecking and higher mortality.

6.1.2 Broilers

Results from studies comparing health and welfare in different broiler production systems depends on which genotypes that were used in the study. The slow growing genotypes are becoming more and more common and seem to fit better in the organic systems. Therefore, in some studies it may be unclear if it is the genotype of the birds or the production system that is the most contributing factor. One important welfare problem in all broiler production is different forms of contact dermatitis; foot pad dermatitis and hock burns. There are not many studies regarding this problem in organic production, and some findings are contrasting (van der Weerd et al., 2009). Pagazaurtundua & Warriss (2006) compared foot pad dermatitis in broilers from 91 farms and five production systems. It was shown that the highest prevalence was found in organic systems. On the other hand, Broom & Reefmann (2005) investigated lesions in broiler carcasses and found that hock burns were more common in conventional broiler production systems than in organic systems. Tuyttens et al. (2008) reported that organic birds tended to have less contact dermatitis. Independent of production system, it is however clear that the prevalence of contact dermatitis often is unacceptably high. The occurrence of foot pad dermatitis has been found to be different in different lines (Kapell et al., 2012; Ask, 2010; Kjaer et al., 2006), have moderate heritabilities (Kapell et al., 2012; Ask, 2010; Kjaer et al., 2006) and GxE interactions have been found (Kapell et al., 2012). Also hock burns seem to have a genetic background (Ask, 2010; Kjaer et al. 2006). Tuyttens et al. (2008) compared birds from conventional and organic farms and showed that the organic birds had a better aggregated welfare index compared to the conventional ones.

In broilers, much of the research focused on health, welfare and production of the slow growing genotypes. Many studies have shown that slow or medium growing genotypes (such as Gourmet, Kabir, Lohmann and others) have many advantages regarding health. One of the largest health problems when using fast growing birds is leg problems, which in many studies is clearly lower (or absent) in more slow growing genotypes (Fanatico et al., 2008; Rack et al., 2009; Tuyttens et al., 2008; Castellini et al., 2002; Julian, 1998). Also the mortality in organic housing systems is often higher among fast growing birds (Fanatico et al., 2008; Castellini et al., 2002) and it is concluded that the slow growing birds are more suitable for organic production (Fanatico et al., 2008; Castellini et al., 2002).

6.2 Behaviour

6.2.1 Laying hens

Feather pecking and cannibalism are the two most important unwanted behaviours in poultry production. They are said to be redirected explorative/foraging behaviour and start when the animals cannot fulfil their behavioural needs. The environment has large impact on the behaviour (e.g. Drake et al., 2010; Lambton et al., 2010) but it is also known that genetics plays a clear role (e.g. Rodenburg et al., 2003; Kjaer et al., 2001). Regarding animal welfare, the behaviour is not only detrimental for the receiver, but it is also a clear sign that the behavioural needs of the performer are not fulfilled. The prohibition of cages in organic poultry production promotes natural behaviour. The larger group sizes in the loose house systems may however compromise welfare if one individual starts to feather peck. In the case of an outbreak of feather pecking, the number of potential victims in a cage is very limited. Many more birds are affected in a free-range system and that is probably one reason for this behaviour being more common in loose housing systems. However, to our knowledge, there are no Norwegian studies on how common feather pecking is in the different production systems. As mentioned in section 6.1.1, in many other countries beak trimming is allowed on conventional farms, hence

there is probably a larger difference between production systems in these countries compared to Norway.

It is well known today that behaviour is affected by both genetic makeup and environment. The birds used in egg and meat production today are highly selected for production for many years. Some researchers claim that this intense selection for production has had unfavourable and unintentional effects also on the behaviour of the animals (Rauw et al., 1998).

There have been some studies regarding layers and differences in behaviour between genotypes. For example, Mugnai et al. (2011) compared the high producing Brown Hyline and the lower producing Ancona in both an organic system and in cages. Feather pecking was higher in the Brown Hyline hens irrespective of system, and the amount of feather pecking was highest in cages. The Ancona hens in the organic system also showed a better feather condition compared to the other groups. They also showed differences when measuring tonic immobility (TI, a test in which a longer latency is said to indicate stress/fear). The Ancona hens showed shorter TI, and an interaction between genotype and production system was observed. For Ancona, the longest latencies were found among caged birds and vice versa in the Hylines. Mahboub et al. (2004) found differences between brown and white layers, in which the brown spent more time on pasture and had shorter TI. Also Kjaer et al. (2002) found differences between layer genotypes regarding plumage damage and mortality due to pecking, but the level of amino acids and other environmental factors only showed minor effects.

In Sweden, there has been an attempt to produce a cross of White Leghorn and Rhode Island Red to produce a hen that could produce eggs also with a more simple feed. This so called “Swedish hen (SH)” showed to have a different behaviour; the SH having better plumage condition and using the outdoor area more, compared to LSLs (but less compared to Hylines) (Lagerkvist et al., 2005).

6.2.2 Broilers

Regarding broilers, there are clear differences in behaviour between fast and slow growing genotypes. The slow growing birds are more active, explorative and often spend more time outside (Almeida et al., 2012; Fanatico et al., 2008; Castellini et al., 2002; Bizeray et al., 2000; Siegel et al., 1997). Castellini et al. (2002) compared fast (Ross), medium (Kabir) and slow (Robusta maculate) growth and both the medium and slow genotype were more active, spent less time lying and spent more time outdoors. They also had a quicker reaction in a tonic immobility test and the author therefore suggested that the medium growth genotypes were most suitable for commercial organic production of poultry meat.

6.3 Nutritional requirements

6.3.1 Laying hens

One challenge in organic poultry production is to fulfil the protein requirements. The requirement of 100% organically produced feed and the prohibition of synthetic amino acids and GMO, as well as limited access to approved raw materials, makes it challenging to meet the birds’ need of amino acids (Lagerkvist et al., 2005). To use genotypes with lower protein requirements and higher tolerance to less balanced diets would be an advantage for all kinds of poultry production. Some producers claim that this even is a must in order to be able to continue to produce organic eggs. “The Swedish hen” was developed with the purpose of developing a hen that could manage a low protein diet. It

was concluded that SH and Hyline hens were better adapted to the organic system (Elwinger et al., 2008).

6.3.2 Broilers

The problem with fulfilling amino acid requirements is largest among layers since the slower growing broilers have lower protein requirements (Rack et al., 2008; Zollitisch & Baumung, 2004). Rack et al. (2009) showed that fast growing Cobb birds decreased their average daily gain when given access to pasture, but this was not the case with the slower growing gourmet birds which suggest a GxE interaction. This gives yet another argument for the slow growing broilers in organic production.

6.4 Production

6.4.1 Laying hens

Many studies show that the productivity of laying hens generally is lower in organic production than in conventional production (Leenstra et al., 2012; Mugnai et al. 2011). The genotype seems to have an impact and different birds may be differently advantageous in different environments. Tumova et al. (2011) tested four different brown hybrids in loose housing system, conventional and enriched cages. They found that genotype had more effect on production than housing, but also found interactions between genotype and housing regarding egg weight, yolk and albumen weight and yolk colour. The authors concluded that this is consistent with other findings. The experimental hen "The Swedish hen", selected for a good performance in low nutrient systems, had a lower production than Lohman and Hyline, but when fed a low protein diet, the production deteriorated more in Lohmann and Hyline compared to SH (Lagerkvist et al., 2005). SH is not used in commercial production.

6.4.2 Broilers

Slow growing broilers are getting more and more common in organic broiler production. It is in their nature to grow slower and have a different meat quality. They have less efficient feed conversion rate, lower breast meat yield, lower carcass weights and higher drip loss (a measure of water holding capacity) (Almeida et al. 2012; Fanatico et al., 2008). However, it seems to be some interaction between production system and genotype. As an example, Rack et al. (2009) compared fast growing Cobb 500 and slow growing Gourmet birds in different production systems. Access to pasture decreased the average daily gain of Cobb chickens, but not the Gourmet birds. In Cobb birds, the methionine conversion rate was improved with pasture, while the Gourmet birds were not affected. This led to the conclusion that the slow growing birds were more suitable for organic production. Fanatico et al. (2008) could show that, when given a low-nutrient diet, fast growing birds could compensate for this by eating more, while slow growing genotypes showed a decreased weight gain.

7. Questionnaire

7.1 Methods

An internet based questionnaire was sent to 37 producers of organic eggs, 3 broiler producers and one turkey producer. Information about the producers were received from the Debio database and the selection criterion was that the farmer should house at least 100 animals per year.

The questionnaire was sent via e-mail as an internet based survey produced with QuestBack. The survey consisted of questions on breed choice, satisfaction with the available animal material and important animal characteristics in organic production. Two weeks after the first invitation, a reminder was sent. We also phoned all producers to remind them about the questionnaire. See appendix 1 for the detailed questionnaire.

For the majority of the questions, the respondents could give a grade between 1 and 5, where 1 corresponds to for example “not satisfied at all” and 5 “very satisfied”.

7.2 Results

We received answers from 16 egg producers (respondent rate 43%), three broiler producers (100% respondent rate) and the turkey producer.

7.2.1 Laying hens

The respondents had between 90 and 7500 laying hens, (mean±S.E. 4167±874). Of the 20 producers in Norway that kept the maximum number of allowed hens (7500), eight responded to the questionnaire. They had been producing organic eggs between three and 37 years.

Mortality

Not all respondents reported mortality rates. Some did not give any numbers at all, some gave an interval. Among the 13 that gave mortality rates, the mortality was between 0 and 8% (3.95±0.78%).

Animal material in own production

The most common hybrid was Lohmann, used by 13 producers. Out of those, five reported white Lohmann, one used both white and brown Lohmann and seven did not report which type. Two producers used Dekalb. The respondent with the lowest number of laying hens used small, purebred breeds.

On the question how satisfied the respondents were with their hybrid, they were given a scale between one and five, where one was “not satisfied at all” and five corresponded to “very satisfied”. On average, the respondents graded it as 3.75±0.23. For more exact numbers, see fig. 1.

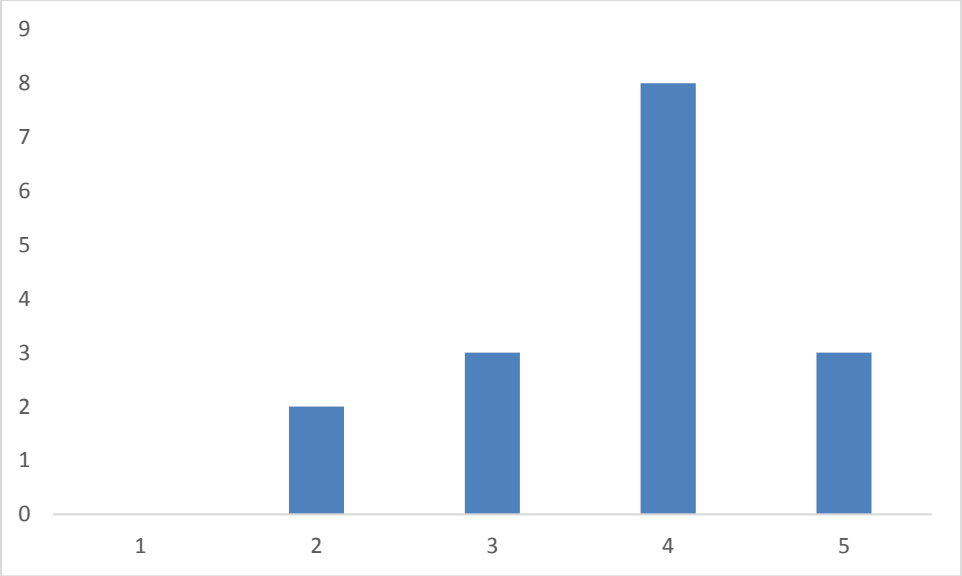

Figure 1. Frequency figure of number of respondents that graded their satisfaction (on a scale from 1 to 5, x-axis) with their own hybrid between 1 and 5.

The answers to the question on why/why not the producers using Lohmann and Dekalb were satisfied with the hybrid they used, resulted in a range of answers that are summarized in Table 1.

Table 1. Positive and negative traits with Lohmann and Dekalb. The number of respondents reporting this trait within brackets.

Genotype	Positive	Negative
Lohmann	Good production (5)	Bad plumage (2)
	Small, less maintenance feed (1)	Bad shell quality (1)
	Good outside (2)	Could go out more often (1)
	Low mortality (3)	Variation between batches (2)
	Good temperament (2)	Stress (1)
		Not robust (1)
Dekalb	Calm (1)	Goes outside seldom (1)
	Good production (1)	
	Profitable production (1)	

Three of the respondents had switched from another genotype the last three years. One switched from brown to white Lohmann, one from hybrids to purebred hens and the third respondent tried Isa Vario but used Dekalb now.

Four respondents planned to change to another hybrid in a near future. Two producers will try Dekalb instead of Lohmann, one respondent using Lohmann wanted to include more purebred animals and the smallest producer wanted to use heavier breeds to cross with the lighter layers.

The respondents gave different reasons for changing/not changing breeds. The ones who had tried other genotypes had different problems with other genotypes. Smaller producers said that they wanted to use more original breeds and one wanted to do a crossing with heavier breeds to be able to use the males for meat production. The respondents that did not change were usually happy with production and temperament in their production. At least three producers mentioned that there really wasn't any other choice. It was

mentioned that it can be difficult to get organic young birds and that long transports is avoided. Two producers that used Lohmann wanted to test Dekalb.

Animal material available in Norway

On the question whether or not the producers were satisfied with the genetic material available in Norway, the average was 3.56±0.18 (1=not satisfied at all, 5=very satisfied). The ones giving higher grades commented that they were happy with the animals. Others commented that they wanted more hybrids that were suitable for organic production, even if the ones they used worked well. One meant that even if the production is good, they animals are not bred to fit into organic production. One producer was interested in Lohmann Silver, which is used a lot in other European countries.

On average, the respondents rated their freedom to choose animal material to on average 2.50±0.27. One producer wished for a certain hybrid, one responded that they needed to place the order very early to get organic hens from day one, one producer commented that there was only one genotype that was suitable and two respondents wrote that they followed the recommendations from the breeder.

Many of the respondents scored high on the question "How important do you think it is with a genotype that is especially selected for organic production" with an average of 4.00. We also asked the respondents to list traits that they perceive to be of certain importance for a welfare friendly and profitable organic production. These answers are listed in table 2.

Table 2. Traits that the producers perceive to be of importance for successful organic farming. Number of respondents that mentioned this trait is within brackets.

Category	Important traits
Production	Good egg laying capacity (5)
	Good egg weight/size (2)
	Good egg quality (2)
	Lower production (1)
Health & robustness	Healthy (2)
	Robust/strong (4)
	Low mortality (2)
	Being able to go out in all weathers (3)
	Long production life (1)
Behaviour	Calm/not stressed (6)
	Behaviour/temperament (2)
	No feather pecking/cannibalism/aggressiveness (3)
	Spending time outdoors (2)
	Harmonic flock
	Easy to occupy indoors
Other	Good plumage (2)
	Feed efficiency

7.2.2 Broilers

Mortality

One of the producers had a mortality of 3.3%, the other two reported 5%.

Animals in own production

All producers used Ross Rowans and all three producers gave a 3 when scoring how satisfied they were with the animals. None of them planned to change. Two of the producers commented that the birds they use grow too fast and are too big at slaughter and wished for even more slow growing birds. They reckoned that this would be better for the animals and for the consumers. Although, one concern with a smaller bird is that the cost for the one day old chickens are so high that the production would be more expensive. One producer also commented that the birds are too passive and difficult to get out on the pasture. It was also commented that, despite the problems, Ross Rowan is the best choice today.

Animal material and organic production in Norway

On the question about how satisfied the respondent was with the animal material available in Norway, two of the respondents gave the grade 2 and one gave a 3 (1=not satisfied at all, 5=very satisfied). It was commented that the birds have the wrong genetics and that the producers wish to have a crossing with a lighter bird to make them lighter and more robust. One producer also emphasized the importance of an organic breeder.

When grading to which extent they had freedom to choose the animal material, all scored 1 and it was commented that there are no genotypes that are especially suitable for organic production.

Regarding the question on how important it is with a breed especially suitable for organic production, one respondent scored 3 and two respondents scored 5.

Traits that were thought to be important in organic production were calm animals, slow/natural growth, good meat quality, birds that want to go out on pasture, no feather pecking, strong legs and a good immune defence.

7.2.3 Turkeys

There is only one producer of organic turkeys in Norway, producing 14 000 turkeys.

The breed used is But 10 and the respondent rated the satisfaction with this breed as a 3 and commented that the breed isn't ideal for organic production, but that it is the best breed available. The animals grow too fast, which can lead to leg problems and diseases as young. The disease situation improves as soon as the animals can go out on pasture. The producer imported Norfolk black males that were crossed with the But 10s which gave a slower growing bird and decreased the leg problems dramatically.

Most of the mortality occurred among the young chickens (1-45 days old). A smaller percentage of the animals die during transport when they were 6 weeks old and the remaining died from six weeks until slaughter. The majority of these older birds were culled because of leg problems.

When asked how satisfied the respondent was with the animal material in Norway, this was graded with a 2 with the comment that the genetics of the animals is not good enough. The freedom to choose genetic material was rated as 1 with the comments that there are no animals especially suited for organic production. On the question about how important it was with a breed especially selected for organic production, the respondent graded it as very important.

Traits that were thought as especially important for an animal welfare friendly and profitable organic production were mobility, willingness to pasture, good natural growth and calm animals with low level of pecking.

8. Discussion

As earlier mentioned, there is a lack of studies on genetic material in organic poultry production. And to our knowledge, no such studies have been performed in Norway which makes it difficult to draw any certain conclusions about the situation on how suitable the different hybrids are. Although, the small questionnaire presented in this report may at least give a first indication on the situation in Norwegian organic poultry production.

It is well known that many traits influencing animal welfare have a genetic background and that different individuals/breeds differ in some traits, physiological as well as behavioural. It is also clear that different animal properties may be beneficial in the different situations that come with different production systems. Hence, it is reasonable to think that different genetic makeup may be more or less successful in different environments. This has been shown in several of the studies that are reviewed in the literature section in this report. This is probably the most important argument that animals especially selected for organic production would be beneficial for both animals, farmers and consumers.

Even if there are some clear benefits with an "organic selection program", there are also obstacles. As mentioned, Norway (or even Scandinavia) does not have a commercial selection program for poultry. Instead, the selection is performed by a limited number or international companies. This means that the Norwegian producers have close to no influence on the available genetic material. It is also not always clear exactly how the breeding companies are performing their selection. Norway is a small country and the organic production of poultry products in Norway is still small. This is probably one of the reasons why rather few hybrids are available. The situation is more or less the same in for example Sweden, even if some other strains are used. Layers available are Bovans Robust, Bovans Brown, Hyline, Lohmann LSL and Lohmann brown. There is also a new strain, Lohmann converter (Odelros, Å. Pers. Comm. 10 november 2013). Since the production systems are very similar in Norway and Sweden it is difficult to speculate in why different strains are used.

8.1 Laying hens

As earlier mentioned, the results in the studies performed on different breeds/hybrids in organic egg production may be difficult to interpret. The animals are of different strains in the different studies and can hence not be compared. The studies are performed in different countries and with different experimental designs and the modern hybrids are developed rather quickly. However, it can be concluded that there are differences that clearly depend on the genetics of the animals and that this can have impact on both profitability and animal welfare.

In the questionnaire, the 13 producers that gave specific numbers reported mortality rates between 0 and 8% with an average below 4%. These numbers should be taken cautiously due to the low number of producers and that it in some cases may be an estimate. Organic production is said to have higher mortality compared to conventional production. When comparing with conventional production in Norway, it is indeed a lower mortality in cages (2.8%), but the mortality is comparable to what it is in other loose housing systems (5%). As earlier mentioned, one difference between Norway and some other European countries is that beak trimming is allowed in conventional production in some other countries. This

may be one of the reasons why the mortality is higher in organic production and why this difference seems to be smaller in Norway.

The egg producers in our questionnaire seem to be rather satisfied with the hybrids they use in their own production, with an average grade of 3.8 (where the score 5 five was "Very satisfied"). When reading the comments to this question, it is rather clear that different producers have different success with the hybrids. For example, there were producers mentioning temperament as a positive trait for the Lohmanns, while others mentioned temperament as a negative trait.

Even if many of the producers were rather happy with the animal material offered in Norway, some commented that they would like more choices and hybrids that were especially suitable in organic production. This is also reflected in the answers on the question about the freedom to choose hybrids in their production, which was rated rather low.

It is interesting that despite the satisfaction with their own animal material, many of the respondents thought it was important with a special selection program for organic hens. And many of the producers agreed which traits that are of special importance. The three traits that were mentioned most often were production, calmness/temperament and robustness. This shows that the producers see that a good animal in organic production must not only have a good production, but also a good health and proper behaviour. We propose that this list of important traits should be complemented with a scientific study about traits important in organic production in Norway and then used in the future work regarding genetic material in organic production.

An ethical problem within egg production in general is that all male chickens are killed at birth since they are not useful in the egg production and it is not profitable to use layers for meat production. Developing a dual purpose chicken as a niche production would be one possibility to solve this.

8.2 Broilers

The situation for the broilers is somewhat different compared to the laying hens. There are regulations that in practice implies that only slow growing birds can be used. In Norway, this is the hybrid Ross Rowan. As mentioned in the literature review, the slower growing animals have a less efficient production, but usually they have better health and welfare compared to the very fast growing commercial broilers.

All three respondents in our questionnaire were sufficiently satisfied with Ross Rowan, even if they thought that they still grew too fast. Still, there was a concern about the profitability if using even slower growing birds. The producers were not very positive to the animal material offered in Norway and all thought that they had a very low freedom to choose which animals they want to have in their production. It was commented that the animals did not have the right genetics for organic production and that it would be positive with one organic breeder so that the animals could be classified as organic already on day one. This would mean that the producers could avoid the waiting period and hence, could slaughter the animals earlier, avoiding the animals growing too heavy.

The above opinions were also reflected in that the broiler producers thought it was very important with a bird that is especially selected for organic production. And some farmers thought that a lower production (growth) would be beneficial. Otherwise, many of the traits were similar with the ones that the egg producers specified.

One problem with organic broiler production, also brought up by the producers, is the lack of an organic breeder. Since the chickens are conventional when they arrive to the producers as one day old chickens, they need to be kept for the whole withdrawal period which is 10 weeks. Although slow growing chickens are used, it was commented that they grow too heavy during this time being a dilemma for animal welfare. The withdrawal time is of importance for the organic principles, but this cannot compromise animal welfare. We strongly suggest that it is investigated how large this problem is. If it is found that the withdrawal time has a negative effect on bird welfare, it should be considered to temporarily shorten the withdrawal time.

8.3 Possible strategies and proposals for the future

We clearly see the benefits with birds that are more suitable for organic production compared to the ones that are available in Norway today and believe that it would be a fruitful way forward regarding animal welfare. However, we also see the difficulties in realising this with today's breeding system for poultry. There is a large genetic variation within different poultry breeds, and the limitations in developing a national selection program for organic production do not lie within genetics, but within economics. To develop organic production of eggs and poultry meat and using animals that fit better to the production system, we see four main alternatives for the future:

1. **Investigate the hybrids that are available today more thoroughly**

For the layers, it is not really investigated which of the four available hybrids is most successful regarding welfare in the organic production system. By performing a scientific study to map the traits and welfare in organic production, a more realistic advice could be given to the farmer. For broilers and turkeys, there is more or less only one easily available breed in Norway today.

This is an alternative that doesn't require any changes in the available animal material and realistic to perform. We think that this would be a good start for developing organic poultry production. Although, as earlier mentioned, the breeding companies can develop their strains very fast which may lead to such information being less useful after a few years. Moreover, there may be alternatives that lead to greater improvements.

2. **Investigate other available hybrids that are not yet on the Norwegian market**

There are several other hybrids that are not available in Norway and some are marketed as fitting alternative production systems. I.e. point 1 could be expanded to comprise also other hybrids. This would also be a good alternative for broiler and turkey production. This alternative has the opportunity to lead to even more accurate advice for the farmers and would perhaps lead to enough inquires for new genotypes in Norway to make it profitable for the importers.

3. **International collaboration**

As earlier mentioned, Norway is a small country with a small production and hence, has small opportunities to influence the breeding companies to select animals in a certain direction. If organic organisations in several countries could work together with one of the breeding companies to develop a specific selection program, this could be a more realistic option. Hence, it is of highest importance with an open and international discussion between the different national organic interest organisations. It would probably be of interest with a Nordic collaboration.

4. **A national selection program**

As today, we do not see this as a realistic option due to economic reasons.

9. Concluding remarks

- With the range of bird breeds and hybrids available, the genetics is probably not the limitation for developing a selection program for organic production. However, there are economic limitations since the national production still is small.
- Even though there is some research on welfare and genetics in organic poultry production, there is a lack of research at a national/Nordic level.
- The production would benefit from a strong Nordic collaboration regarding research, advice and breed selection.
- Even though organic production is seen as somewhat challenging, there are many successful producers. These examples should be highlighted and their experience shared.

10. References

Almeida, G.F.D., Hinrichsen, L.K., Horsted, K., Thamsborg, S.M. & Hermansen, J.E. 2012. Feed intake and activity level of two broiler genotypes foraging different types of vegetation in the finishing period. Poultry Science 9, 2105-2113.

Animalia. Kjøttets tilstand 2012. Status i norsk kjøtt- og eggproduksjon.

Ask, B. 2010. Genetic variation of contact dermatitis in broilers. Poultry Science 89, 866–875.

Berg, C. 2001. Health and Welfare in Organic Poultry Production. Acta vet. Scand. Suppl. 95, 37-45.

Bizeray, D. Leterrier, C., Constantin, P., Picard, M. & Faure, J.M. 2000. Early locomotor behaviour in genetic stocks of chickens with different growth rates. Applied Animal Behaviour Science 68, 231-242.

Boelling, D., Groen, A.F., Sørensen, P., Madsen, P. & Jensen, J. 2003. Genetic improvement of livestock for organic farming systems. Livestock Production Science 80, 79-88.

Branciari, R., Mugnai, C., Mammoli, R., Miraglia, D., Ranucci, D., DalBosco, A. and Castellini, C. 2009. Effect of genotype and rearing system on chicken behavior and muscle fiber. Journal of Animal Science 87, 4109-4117.

Broom, D.M. & Reefmann, N. 2005. Chicken welfare as indicated by lesions on carcases in supermarkets. British Poultry Science 46, 407-414.

Castellini, C., Bosco, A.D., Mugnai, C. & Bernardini, M. 2002. Performance and behaviour of chickens with different growing rate reared according to the organic system. Italian Journal of Animal Science 1, 291-300.

Council regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs.

Drake, K.A., Donnelly, C.A. & Dawkins, M.S. 2010. Influence of rearing and lay risk factors on propensity for feather damage in laying hens. British Poultry Science 51, 725-733.

Elwinger, K., Tufvesson, M., Lagerkvist, G. & Tauson, R. 2008. Feeding layers of different genotypes in organic feed environments. British Poultry Science 49.

Fanatico, A.C., Billai, P.B., Hester, P.Y., Falcone, C., Mench, J.A., Owens, C.M. & Emmert, J.L. 2008. Performance, Livability, and Carcass Yield of Slow- and Fast-Growing Chicken Genotypes Fed Low-Nutrient of Standard Diets and Raised Indoors or with Outdoor Access. Poultry Science 87, 1012-1021.

Hermansson, A. & Odelros, Å. 2011. Djurvänlig och konkurrenskraftig äggproduktion i Sverige – nulägesanalys 2010. Svenska ägg.

Julian, R.J. 1998. Rapid growth problems: ascites and skeletal deformities in broilers. Poultry Science 77: 1773-1780.

Kapell, D.N.R.G., Hill, W.G., Neeteson, A.M., McAdam, J., Koerhuis, A.N.M. & Avendano, S. 2012. Genetic parameters of foot-pad dermatitis and body weight in purebred broiler lines in 2 contrasting environments. Poultry Science 91, 565–574.

Kjaer, J.B., Sorensen, P. & Su, G. 2001. Divergent selection on feather pecking behaviour in laying hens (Gallus gallus domesticus). Applied Animal Behaviour Science 71, 229-239.

Kjaer, J.B. & Sørensen, P. 2002. Feather pecking and cannibalism in free-range laying hens as affected by genotype, dietary level of methionine + cysteine, light intensity during rearing and age at first access to the range area. Applied Animal Behaviour Science 76, 21-39.

Kjaer, J.B., Su, G., Nielsen, B.L. and Sørensen, P. 2006. Foot Pad Dermatitis and Hock Burn in Broiler Chickens and Degree of Inheritance. Poultry Science 85, 1342–1348.

Lambton, S.L., Knowles, T.G., Yorke, C. & Nicol, C.J. 2010. The risk factors affecting the development of gentle and severe feather pecking in loose housed laying hens. Applied Animal Behaviour Science 123, 32-42.

Lagerkvist, G., Elwinger, K. & Tauson, R. 2005. Feeding layers of different genotypes in an organic feed environment. 56th Annual meeting of the European Association for Animal Production, Uppsala, Sweden.

Leenstra, F., Maurer, V., Bestman, M., van Sambeek, F., Zeltner, E., Reuvekamp, B., Galea, F. & van Niekerk, T. 2012. Performance of commercial laying hen genotypes on free range and organic farms in Switzerland, France and The Netherlands. British Poultry Science 53, 282—290.

Leenstra, F., Maurer, V., Bestman, M., Zeltner, E., van Niekerk, T., Galea, F. & Reuvekamp, B. 2011. Selection and characterization of low input farm groups in 3 macro-climatic regions in Europe for inclusion in a “farmer participatory” performance recording network (FP-PRN) and performance recording of currently used layer genotypes. Proceedings of the First LowInputBreeds Symposium, March 15 & 16, 2011, Wageningen, The Netherlands.

Lund, V. & Algers, B. 2003. Research on animal health and welfare in organic farming—a literature review. Livestock Production Science 80, 55-68.

Lund, V. 2006. Natural living – a precondition for animal welfare in organic farming. Livestock Science 100, 71-83.

Mahboub, H.D.H., Müller, J. & Von Borell, E. 2004. Outdoor use, tonic immobility, heterophil/lymphocyte ratio and feather condition in free-range laying hens of different genotype. British Poultry Science 45, 738-744.

Mugnai, C., Dal Bosco, A., Moscati, L., Battistacci, L. & Castellini, C. 2011. Effect of genotype and husbandry system on blood parameters, oxidative and native immune status: welfare and implications on performance of organic laying hens. The Open Veterinary Science Journal 5, 12-18.

Norwegian Agricultural Authority. 2013. Produksjon og omsetning av økologiske landbruksvarer. Rapport 2012. Ed.: Røsnes, E. & Thanh Ha, T. Rapport 12/2013.

Norwegian Food Safety Authority. Veileder til forskrift om økologisk produksjon og merking av økologiske landbruksprodukter og næringsmidler av 4. Oktober 2005 nr. 1103. Veileder B. Utfyllende informasjon om økologisk landbruksproduksjon.

Pagazaurtundua, A. & Warriss, P.D. 2006. Levels of foot pad dermatitis in broiler chickens reared in 5 different systems. British Poultry Science 47, 529-532.

Rack, A.L., Lilly, K.G.S., Beaman, K.R., Gehring, C.K. & Moritz, J.S. 2009. The effect of genotype, choice feeding, and season on organically reared broilers fed diets devoid of synthetic methionine. Journal of Applied Poultry Research, 18, 54-65.

Rauw, W.M., Kanis, E., Noordhuizen-Stassen, E.N. & Grommers, F.J. 1998. Undesirable side effects of selection for high production efficiency in farm animals: a review. Livestock Production Science 56, 15-33.

Rodenburg, T.B., Buitenhuis, A.J., Ask, B., Uitdehaag, K.A., Koende, P., van der Poel, J.J. & Bovenhuis, H. 2003. Heritability of feather pecking and open-field response of laying hens at two different ages. Poultry Science 82, 861-867.

Siegel, P.B., Picard, M., Nir, I., Dunnington, E.A., Willemsen, M.H.A. & Williams, P.E.V. 1997. Responses of meat-type chickens to choice feeding of diets differing in protein and energy from hatch to market weight. Poultry Science 76, 1183-1192.

Sundrum, A. 2001. Organic livestock farming. A critical review. Livestock Production Science 67, 207-215.

Tumova, E., Englmaierova, M., Ledvinka, Z., Charvatova, V. 2011. Interaction between housing system and genotype in relation to internal and external egg quality parameters. Czech Journal of Animal Science 56, 490-498.

Tuyttens, F., Heyndrickx, M., De Boeck, M., Moreels, A., Van Nuffel, A., Van Poucke, E., Van Coillie, E., Van Dongen, S. & Lens, L. 2008. Broiler chicken health, welfare and fluctuating asymmetry in organic versus conventional production systems. Livestock Science 113, 123-132.

Van der Weerd, H.A., Keatinge, R. & Roderick, S. 2009. A review of health-related welfare issues in organic poultry production. World's Poultry Science Journal 65, 649-684.

Zeltner, E. & Maurer, V. 2009. Welfare of organic poultry. In: Proceedings of Poultry Welfare Symposium Cervia, Italy.

Zolltisch, W. & Baumunb, R. 2004. Protein supply for organic poultry: options and shortcomings. In: Proceedings of the 2nd SAFO Workshop, Witzenhausen, Germany.

Appendix 1.

Dyremateriale i økologisk fjørfeproduksjon

En viktig regel i økologisk husdyrproduksjon er at dyrene skal være av en robust rase, og ha gode forutsetninger for å produsere og trives i økologisk drift. For å undersøke hvordan rasevalg i økologisk fjørfe produksjon blir fulgt i Norge i dag, vil vi be deg som produsent om å svare på 15 korte spørsmål. Det vil ta ca. 15 minutter.

Svar vil bli behandlet anonymt. Navn vil kun bli brukt for å unngå utsending av unødvendig påminnelse.

Takk for at du vil samarbeide, det betyr mye for oss!

Basisinformasjon:

1. Navn:
2. Hvilken produksjon har du – egg, slaktekylling, kalkun
3. Antall dyr/år
4. Hvor lenge har du drevet med økologisk fjørfeproduksjon?

Dyr:

5. Hvilken rase/hybrid/genotype brukte du til ditt siste innsett?
6. Er du fornøyd med rasen/hybriden/genotypen? Angi hvorfor.

   1 2 3 4 5
   1 = veldig misfornøyd
   5 = veldig fornøyd

   Hvorfor er du fornøyd/misfornøyd?

7. Hvor kjøper du dine dyr?
8. Har du byttet rase/hybrid/genotype de siste tre årene? Hvis ja, angi hvorfor og fra/til hvilke raser?.

   Ja Nei

   Hvorfor/hvorfor ikke, og hvilken rase byttet du fra/til?

9. Kommer du til å bytte rase/hybrid/genotype i nær fremtid? Hvis ja, kommenter hvorfor og til hvilken rase.

   Ja Nei

   Hvorfor/hvorfor ikke, og hvilken rase vil du evt. bytte til?

10. Hvor høy var dødeligheten i ditt siste innsett?
    Kommentar?

Egenskaper/dyrematerialе i økologisk produksjon

11. Er du fornøyd med dyrematerialet som finns tilgjengelig i Norge i dag?

    1 2 3 4 5
    1 = veldig misfornøyd
    5 = veldig fornøyd

    Hvorfor er du fornøyd/misfornøyd?

12. Hvor stor frihet har du i dag til å velge det dyrematerialet du vil ha til din produksjon?

    1 2 3 4 5
    1 = liten frihet
    5 = stor frihet

    Kommentar

13. Hvor viktig synes du det er at det finns en tilgjengelig rase/genotype/hybrid som er spesielt selektert for økologisk produksjon?

    1 2 3 4 5
    1 = ikke viktig
    5 = veldig viktig

    Hvorfor?

14. Hvilke egenskaper hos dine fjørfe mener du er spesielt viktige for å kunne drive en dyrevennlig og lønnsom økologisk produksjon?

15. Hvor fornøyd er du generelt med dagens økologiske regelverk for din produksjon av egg/kalkun/slaktekylling?

    1 2 3 4 5
    1 = veldig misfornøyd
    5 = veldig fornøyd

    Kommenter hvorfor/hvorfor ikke og kom eventuelt med forslag til endringer.