Dansk version

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The Landrace

Newsletter from Landsorten
No. 13, 2024

Headlines in the newsletter

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News from the Countryside

Landsorten will hold a general assembly on 27 February 2024 at 13:00. The general assembly takes place at Jernbjerggård C. A. Olesensvej 2, 4200 Slagelse. Before the general assembly, there will be presentations on relevant topics.

General Assembly in Landsorten
Tuesday 27 February 2024
Address: ZBC, C.A. Olesensvej 2, 4200 Slagelse

Programme:
10.00-10.30 welcome and coffee
10.30-11.00 Challenges in keeping the countryside's grain cultivation clean by Peter Møller Nielsen, agricultural teacher at ZBC
11.15-12.00 Marketing of speciality products now and in the future by Jan Kristensen, Business Developer at Dansk Cater.
12.15-13.15: Lunch
13.30-15.30 General Assembly in Landsorten

The general assembly is the ideal place to meet and discuss how Landsorten should develop. Which varieties should we focus on? How do we ensure quality and economy? Who has 200kg of naked oats I can buy?

Lone Andreasen and Morten Øster Kristensen from Samsø Mel have been CEO and chairman respectively since the organisation was established, and now they both want to pass the baton to the next generation. At the general assembly, we will introduce the newly appointed director, Henriette Winther, while a replacement for Morten's seat on the board will be elected. Johan Lund, who has helped Bjarne Hansen with seed coordination and member contact, is also temporarily less visible as he will be completing his studies in 2024, so a lot will be different this year.

Henriette Winter joins Landsorten on 1 March as Director, where, in addition to day-to-day operations, she will contribute to the strategic development that Landsorten must constantly consider when building a completely new seed system and food chains for alternative varieties.

Figure 1: Henriette Winther

Henriette is a Cand Merc with many years of experience in product development and marketing, and some of The Landrace's readers may recognise her from her time as a marketing consultant at Organic Denmark or from her time as chief consultant/business developer etc. at Meyers and Madkulturen. Henriette has extensive experience in the development of both local and national food networks, which we hope will be a good ballast for the work in Landsorten.

Contact Henriette at henriette@landsorten.dk

Marketing

There are still good sales opportunities for Mariagertoba in particular. Yields were low and quality bad for all Danish grain in 2023, so stocks of Danish-produced bread grain are already partially or completely empty. If you search #Mariagertoba on Instagram, you can see that the baking nerds are welcoming the flour from Landsorten's producers. So far, there is enough seed and several mills are asking for Mariagertoba grain, but there is a shortage of growers to produce it. If you have 10 or 50 hectares available in your field plan, contact Bjarne Hansen <bjarne@landsorten.dk> whether you just want seed or you want to make a contract with one of Landsorten's mill members.

Spring sowing seeds

More and more farmers are starting to sow spring wheat in the autumn to avoid infestation of the gout fly. As a result, some of Landsorten's spring wheat has already been sown, and there are only limited quantities of most varieties left. However, some selected varieties are still available for sowing. Visit Landsorten's website under Marketplace to see what seed of the different varieties is available.

Mariagertoba is the most widely grown in the Landsorten programme and the one we recommend as the standard wheat. It has a higher gluten content and better quality than other varieties on the market, and it is recognised by the leading bread nerds. Several mills in both eastern and western Denmark are looking for farmers who want to sign a contract for the delivery of Mariagertoba bread grain, so that sales can be secured in advance if there is a demand for it.

Pop Gazelle is a population similar to Mariagertoba, but it is earlier in development and therefore less affected by the gout flies. We don't have large quantities of it, but we actually need a breeder with a few hectares to multiply what little we have.

Many people grow **spring barley,** but it's a little hard to understand why most organic growers choose the short straw, chatty conventional varieties when Landsorten has a very well-functioning straw-rich variety with good weed competition.

Oats theme

Agrologica has joined an inter-Nordic oat project RobOat, and in this newsletter I've started off with some old and new knowledge about oats.

Landsorten's oat varieties

Landsorten has only a few oat varieties on the variety list, and it has been difficult to find growers willing to maintain them. There has been little demand over the years, so wheat has been given a higher priority. However, oats are definitely an interesting crop that seems to be in increasing demand. Therefore, Landsorten would like to advocate for increased interest in oats.

Oil Oats

Common oats have a fat content of around 5-7% and a protein content of around 12, but both fat and protein content depend on growing conditions as well as variety. As in wheat and barley, protein content is directly correlated to nitrogen fertilisation and inversely correlated to yield, and this is also true in oats. The fat content in barley and wheat is fairly constant regardless of variety and growing conditions, but in oats there are very large differences in fat content between varieties and growing conditions. This is because rye, barley and wheat store energy as starch and only have fat in the small germ at the end of the kernel, while oats have the ability to store fat deposits throughout the kernel. Agrologica has bred an oat variety called oil oats, which has a significantly higher fat content than normal oats.

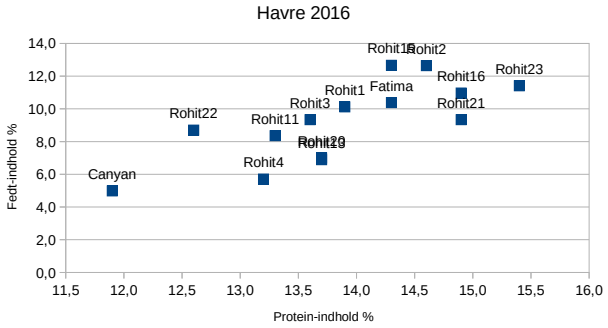

Figure 2Fat and protein content in oil oat selections. The variety 'Canyan' was the most cultivated oat variety in Denmark in the trial year and is in line with common varieties today.

Oat fat is of the valuable omega-3 type, which most consumers in Western societies are under-supplied with. This is not only because we eat too much animal fat compared to fat from the plant kingdom, but also because we feed animals too much starch compared to vegetable fat, so the animal fat also contains more Omega-6 fat than is natural for animals to have. A normal diet in the Western world is 15-17 times as much Omega-6 for every Omega-3, while the recommended ratio is 1-4 Omega-6 for every Omega-3. So, our diet is all messed up, and we know this is the main reason why instead of dying of old age, we should expect an earlier death from cardiovascular disease and cancer, and suffer from Parkinson's, allergies, depression and obesity. Apparently, this is the modern definition of 'living well'.

Landsorten recommends oil oats for both feed and human consumption, even though the yield in kg/ha is expected to be lower, because the lower yield is compensated for by a higher energy and nutrient density, to the benefit of both consumers and especially organic farmers, where both fat and protein supply is limiting in feed value.

Naked oat

Landsorten have two varieties of naked oats, namely Austrian bitter oats and Taliko. In terms of cultivation, there is not much difference. The name bitter oats comes from the fact that oats are usually hairy on the kernel and that the hairs in particular have a bitter flavour. In normally hulled oats, the hairs are worn off during shelling, but if you don't mechanically remove the hairs on naked oats, they take on a characteristic flavour. However, some naked oat varieties are hairier than others, and for example, Swedish Jakob oats are much hairier than Austrian Bitter oats.

For both local oatmeal production, oat drink and animal feed, naked oats have great advantages in avoiding flaking, but for home use, cleaning is still necessary and difficult, as 100% of the oat kernels are never naked.

Winter oats

Common winter oats are oats that can survive the winter. Landsorten's common winter oat has been developed as a CCP, i.e. a cross between many winter oat varieties, where the offspring have simply been allowed to grow and compete each year, so that the best have outcompeted the poorer ones each year. It has had excellent overwintering for the last 12 years in Denmark. The disadvantage of winter oats is that they go into a deeper hibernation in winter than winter rye and winter wheat, so in spring they are a little slow to start competing with weeds. On the other hand, you get big, beautiful grains and an earlier harvest compared to spring oats.

Naked winter oats

Naked winter oats are similar to regular winter oats, but like all naked oats, be aware that the germination can be damaged by excessive harvesting. Furthermore, birds LOVE naked oats, and crows, pigeons and pheasants may feed on the seed, and if the field is small, it can make a big dent in the seeded grain.

New project on semi-loose smut in oats

Agrologica, together with 13 other Nordic partners, has embarked on a major project RobOat on plant breeding of oats. Agrologica's part in the project will be to find resistance genes against semi-loose smut of oat and, if successful, to develop genetic markers.

Fortunately, we haven't seen much smut in oat in Denmark in recent years, which is probably because most oat seed in Denmark is treated with toxic chemicals. In Sweden, on the other hand, there have been several cases last year, including among Allkorn's growers of old oat varieties grown without the use of pesticides.

Semi-loose smut in oat (*Ustilago avenae*) is a disease that resembles a mixture of loose smut in barley and common bunt in wheat. Spores are carried with the

seed, but the infection primarily takes place around flowering, just like loose smut in barley. Here, it is important how open the flowering is, which is controlled by both the weather and the variety. Furthermore, as with common bunt in wheat, there are varieties with specific resistance, which means that these varieties cannot be infected by some pathogens, while they can be infected by other pathogens. It is this last type of resistance that I will focus on in the first instance.

General information about oats past and present

Introduction and overview

Oats are the youngest of the four Danish cereals. In ancient wheat fields, various wild oat species have appeared as weeds, and over time they have adapted to the growing conditions of the cultivation system.

Oats are not similar to other cereals in appearance, but morphologically, oats are not that different from other cereals. In both cases, there is an axis on which there are spikelets. In oats, the stem on which the spikelets are attached is just significantly longer than in the other cereals, giving oats the characteristic "bell-shaped" top.

"The gardener's bells,

rings when he rocks"

(From the Danish children's song "North and South and East and West" by Mogens Lorentzen)

The top of the oat consists of small branches. Each spikelet contains 1-3 flowers, each of which can develop a kernel. Oats prioritise the outer grain in each spikelet first, which is therefore always the largest, and only if there is enough nutrients will the second or third grain develop. In cultivated oat species, 2-3 kernels usually develop in each axis, but the number can depend on the variety and growing conditions. In some wild oat species, there is a loosening layer over the outer grains, making the entire axis act as a dispersal unit, similar to what is seen in spelt and emmer, for example. In cultivated oat species, the loosening layer is located between the individual flowers in the minor axis. In this way, the grains are separated during threshing.

Figure 4: Common oats with few seeds in each spike

Figure 3: Naked oats with multiple seeds in each spike

The core is enclosed by a bract and a bracteole. The bract is the largest, and on it is a larger or smaller stalk, which may be slightly squat. On wild oat species that often appear as weeds, such as wild oats and wild oats, the stack is strongly squat and is spirally twisted under the squat. As the kernel falls to the ground and absorbs moisture, the stack unravels, acting like a drill that drills the seed into the soil. At the root of the stack are bristles that act as barbs when the seed is drilled into the ground.

The history of oat

Oats originated from weeds that appeared in ancient wheat fields. These have gradually adapted to the conditions in the fields, and since oats do better than wheat in damp and cold regions, there are now so many oat weeds that we can talk about an oat field with wheat in it, rather than the other way round. Thus, a new crop has emerged. The oldest oat grains that have been found are in Egyptian tombs from around 2000 B.C. These were undoubtedly wild oat species that appeared as weeds. It is not until around 1000 BC that oats appear in the archaeological finds in such a way that we can talk about an actual crop. Oats are therefore much younger than other cereals, where wheat and barley, for example, can be dated as a cultivated plant as far back as 9,000 BC.

Oats require more moisture than other cereals and therefore thrived as it travelled further up through Europe with arable farming. Furthermore, oat is sensitive to salt stress, which often occurs in arid regions with unsustainable farming systems.

Oats first arrived in Denmark in the Late Bronze Age 1000-500 B.C. Whether this was because the climate became cooler and thus better suited oats, or whether it was due to migrations that brought oats with them, is not known for certain.

As with barley, the oat kernels are harvested together with the inner grains. The inner grains of oats are significantly thicker and larger than those of barley, which gives oats a high fibre content for feed use compared to other cereals. On the other hand, the kernels have not grown together with the kernel as in barley, which makes it easier to de-hull the kernel when it is used for oatmeal, for example. There are naked oat varieties, i.e. oat varieties where the inner kernels fall off during threshing. These varieties have a much lower fibre content and higher digestibility when used as feed. The naked oat (*Avena sativa* ssp. *nudasativa*) is closely related to the common oat. They have the same number of chromosomes and can interbreed. However, there are other differences besides whether the inner names fall off during threshing. Naked oats have a higher fat and protein content than hulled oats. (Note that there are two different plant species (*Avena nuda* and *Avena sativa* var. *nudasativa*) that are both called naked oats. It's quite confusing).

Oats are divided according to the colour of the inner glume name into yellow, white, grey or black oats. The yellow and white varieties have a 24-27% shell share, while the black and grey varieties have a 30-33% shell share. In addition, there are naked oats, which shed their chaff during threshing. Black oats are easy to recognise by the characteristic black inner glumes, while the differences between yellow, white and grey oats can be difficult to see with the naked eye, but white oats fluoresce in ultraviolet light.

Before plant breeding began to utilise the modern understanding of inheritance and genetics, people grew what are known as landraces. Unlike a modern variety, where all plants are genetically identical, a landrace is a population of many genetically different plants. When these are grown for many years in the same location or region, the plants that are best adapted to the climate, soil, etc. will reproduce more than plants that are not so well suited to the growing conditions. In this way, different landraces are adapted to different regions. In the mid-1800s, yellow and white landraces were cultivated in eastern Jutland and on the islands, while grey oat landraces were predominant in the southern parts of Jutland, often in mixtures with lopsided oat (*Avena strigosa*), which is a primitive relative of the common oat (*Avena sativa*). Black oats were cultivated on marshland, in the marshes and in areas that were drained and reclaimed and cultivated from the mid-1800s. In this way, there has been a local adaptation to the fact that grey oats better utilised the nutrients in the soil and could therefore survive on the lean soils, while black oats had a stiffer straw and could therefore better tolerate the high nutrient levels in the low bogs and on the old seabed.

At the end of the 1800s, predominantly landraces were still being grown. In the eastern regions, it was called Danish oats and Provsti oats, but at that time, purebred varieties began to arrive in

Denmark. Oats are predominantly self-pollinating. This means that if you take the seeds from a single oat plant, all the plants that emerge from those seeds will be identical to the parent plant. In this way, you can create a pure-line variety where all plants in a field are genetically identical. This has both advantages and disadvantages. If the growing conditions in the field are uniform and roughly the same from year to year, a pure line variety can be used to find the variety that best suits those growing conditions. As farming techniques improved, growing conditions became more uniform and this helped pave the way for the spread of pure line varieties.

The first varieties to be introduced to Denmark from abroad were Beseler oats from Germany, Abundance from England and Ligowo from France. They didn't gain widespread popularity, but nevertheless showed the way for future development.

The first variety to become widespread was *Yellow Næsgård*, which H.A.B. Vestergaard bred around 1905. Vestergaard bred around 1905 by selecting plants from the *Beseler oats*. Already around 1910, Sejr from the Swedish breeding station Svalöf also became popular, and together with Kron they became the most cultivated varieties at the beginning of the century on good soils. The grey Lyngby Hedehavre was introduced to sandy soils in 1913, and within a few years it became the dominant variety on sandy soils in Denmark, almost completely displacing the old landraces of grey oats.

Oats are traditionally considered to be the most frost-sensitive of the cereals, and in Denmark, oats are only grown as a spring crop. Winter oats have a significantly higher yield potential than spring oats, and winter oats could become an interesting crop in organic farming if they could survive in our climate. Already in an agricultural encyclopaedia from 1875, winter oats are described as a possibility that is used in England and France, among other countries, but that it is doubtful whether it can withstand the Danish winter. This is still the opinion of agricultural consultants over 100 years later. There are approved varieties in several EU countries, and winter oats are also being bred in both Eastern Europe and Sweden.

Ingredients and use

Common oats have a protein content of around 11-13% depending on variety and growing conditions. This is on par with good baking wheat, but digestibility is not as high in oats. In black oats, digestibility is usually higher than in yellow and white oats, and especially in naked oats, digestibility is high and has a favourable amino acid composition. Among other things, the content of the essential amino acid lysine is high, especially in naked oats.

The fat content of oats differs significantly from other cereals. Most grains have a starch-rich endosperm and a germ that contains some germ oil. Since a grain consists of a small germ and a very large endosperm, there are limits to how much oil can be found in regular grains. Oats, on the other hand, have almost all the oil in the endosperm. In some varieties, the fat content is over 11% and in special crosses with wild species, the content has been as high as 18%, which is so high that oil can be pressed from the kernels. In most varieties, however, the fat content is down to 5-8%, which is still about double that of barley, for example. Naked oats generally have a higher fat content than regular oats.

Oatmeal's oil content is not only high. It also has a favourable fatty acid composition with a high content of unsaturated fats, including oleic acid. When used to feed fattening pigs, it causes pork rinds to become soft, which is why feeding fattening pigs a high proportion of oats has been discouraged. Like humans and other monogastric animals, pigs cannot synthesise polyunsaturated fat. In the interests of health, it might be worth considering whether consumers should be encouraged to accept a softer fat structure in animal fat, as this indicates that there are more

unsaturated fatty acids, which is healthy. Oats could therefore benefit from a more frequent presence in the feed of monogastric animals. Traditionally, oats have mostly been used in horse feed because horses are working animals that need the high energy content of oat fat and are also good at utilising the high fibre content.

The fibre content of oats is also interesting in oats. For feed, oats retain the chaff, which makes up 25-30% of the weight and has a high content of coarse fibres. However, the kernel itself also has a high content of water-soluble fibres, the so-called beta-glucans. Water-soluble fibres are very interesting from a nutritional point of view because they help stabilise blood sugar levels, reduce total blood cholesterol levels, especially harmful LDL cholesterol, and aid digestion. Furthermore, oats contain a laxative substance in the bran. Oats are also high in chromium, which, like dietary fibre, reduces sugar and cholesterol in the blood. Oats are therefore a healthy food, especially for diabetes patients and people at risk of cardiovascular disease.

Oats have a higher antioxidant content than other cereals, and black oats are particularly high in antioxidants. Like chromium and dietary fibre, the antioxidants in oats prevent cardiovascular disease by reducing the risk of plaque formation in the blood vessels.

Oats have a lot of good ingredients, but unfortunately, there is also a snake in paradise: Phytic acid. This substance is a chelating agent, i.e. a substance that binds to other substances. Phytin has an unfortunate tendency to bind calcium, zinc, iron and a number of other important minerals in so-called phytates, making them unavailable to the organism. In grains, most of the minerals are found in the bran layer of the kernels, and here the phytate naturally protects the minerals from leaching so that they are available for germination. The phytate is very effective at this task, and the minerals are only released again when the grain "thinks" it is about to germinate - and the grain "thinks" it is about to germinate when it has been warm and wet for a long time. Here, the enzyme phytase will break down the phytic acid and release the minerals. This is why the grain was soaked overnight before being fed to pigs in the old days. Only after soaking can the pigs fully utilise the minerals. Phytic acid can also be a problem in human nutrition because it leads to mineral deficiencies. Menstruating women are particularly vulnerable, and 40% of young women in Western Europe are currently under-supplied with iron, while the figure for older women is around 10-30%. It's grotesque that we nowadays accept living with malnutrition on such a scale! Zinc deficiency is also a pronounced problem among both men and women, and here phytate in cereals plays a crucial role because we get a very large proportion of our iron and zinc from cereal products. If you just look at the list of ingredients in our food, we get enough minerals, but it doesn't help because we can't absorb them as long as they are bound in phytates.

Oats contain very little phytase, only about 5% of the amount in barley and wheat. This should be seen in the context that the calcium content is about 5 times higher in oats than in barley, while the phosphorus content is only 1/5 of that of barley. The phosphorus content is crucial for the availability of calcium. So, even though oats have a significantly higher calcium/phosphorus content than other cereals, the low phytase content is a problem. In whole untreated oatmeal, an overnight soak can break down the phytate, but regular store-bought oatmeal is steamed and toasted, so the heat treatment has broken down the phytase and the phytase cannot break down the phytate. So soaking oatmeal will not help unless it is mixed with flakes of other cereals that have not been heat-treated. Also, whole hulled oat kernels are usually heat-treated to extend their shelf life, so even freshly made home-rolled oatmeal doesn't contribute to our mineral supply. Rye is very high in phytase, so a good nutritional rule of thumb is to always mix some freshly rolled rye flakes into the oats before soaking them overnight.

The high fibre content in oats is healthy for humans because it limits fluctuations in blood sugar levels and thus reduces the risk of obesity and diabetes, but for monogastric livestock, which like humans cannot metabolise fibre and need to grow quickly, the low digestibility and appetite

regulation is a disadvantage. Along with phytate, you should therefore be cautious about feeding oats unilaterally to monogastric animals. An old folk rhyme says:

The blacksmith's pigs

I know a sage
about the blacksmith's pigs.
First they had oats,
they became skinny.

Then they got wheat,
they got fat.
Then they got barley,
then they shot back
.

Then they got milk from a cup,
Then they ran around at a gallop.
Then they had to give their lives,
although they were all so happy.

(Danish folk rhyme)

Therefore, barley has traditionally been fed to pigs to get them to eat more, but oats can be excellent if used correctly. Among other things, the high fibre content helps improve digestion not only for humans but also for animals, which is a benefit for piglets, for example, who often have problems with diarrhoea during weaning. Almost all Danish pigs in industrial production have ulcers in the gland-free part of the stomach, and whether it affects their growth rate is only a question of whether they are slaughtered before the ulcers become too serious. In recent years, Danes have increasingly switched to eating wheat, while oats and barley, which together with rye used to make up the vast majority of our food, have almost disappeared from our food culture. As a result, people are also increasingly prone to digestive problems due to low fibre content in our diet.

Most grains contain gluten, which is a complex protein that is insoluble in water. Most people recognise gluten as the glue that sticks to the dishwashing brush when you clean the bowl after baking. Some people are allergic to gluten to a greater or lesser degree. Some can only tolerate it in limited amounts or a specific type of gluten, while others cannot tolerate even the smallest amount of gluten at all. Oats also contain gluten, but there are various factors that make oats tolerated by most people with gluten allergies. The gluten in wheat is made up of some of the largest molecules found in nature, and since they are not water-soluble, they are very difficult to digest. Gluten in oats is much smaller, so they break down more easily. Coeliac disease and some other gluten-related disorders are triggered by specific fragments (epitopes) of the gluten proteins, and these fragments are not found in the protein of the oat varieties commonly grown in Denmark today. However, they have been shown to be present in some oat varieties, and perhaps more attention should be paid to this in plant breeding so as not to create problems in the future. As a general rule, oats are recognised as gluten-free because they are tolerated by gluten-sensitive patients, although this is not entirely correct, as oats do contain gluten. Another issue is that in some parts of the food industry, oats are processed together with wheat, which contains high amounts of gluten, so some patients may react negatively to an oat product contaminated with wheat. This can be due to the oats being mixed with wheat at the farmer's farm or in the mill. This is why there are certified productions that ensure that the oats are kept separate from wheat throughout the entire process, and this is what is marketed as "gluten-free oats", although technically it should be called "wheat-, barley- and rye-free oats".

Oats have a very high content of vitamin B_1 -vitamin, almost 8 times as much as in wheat. Some people are attacked by mosquitoes more than others, partly because mosquitoes don't like the smell of people who eat a lot of vitamin B_1. The recommended daily nutritional dose is just 5 mg per day, but as a preventive measure against mosquito bites, 300 mg of vitamin B_1 per day is recommended. A large 150g portion of oatmeal contains 225-360 mg, which in principle should be enough to keep the worst mosquitoes away.

Oatmeal

We humans mainly eat oats in the form of oatmeal. These are made by first heavily drying the oats down to around 6% moisture content. This causes the kernel to shrink slightly, making it easier to remove the inner husks that normally surround the oat kernels. This is done on large horizontal millstones placed so far apart that the kernels are not crushed into flour. The result is naked grains. The oat kernels are usually very hairy and these hairs are removed by brushing. Next, the so-called kilning process is started, which consists of steaming the kernels for an hour at around 80-100°C, after which they are dried back by lightly toasting. After another steaming, the water content is increased and the moistened grains are rolled to the final flakes.

The primary purpose of the kilning process is to destroy the lipidase enzyme that prevents the fatty oat kernels from going rancid and developing a bad flavour. Furthermore, the oats become softer to chew, which also affects the flavour. The downside, as mentioned above, is that the kilning also destroys the phytase enzyme, which should help us digest the minerals in the oats. If you buy whole oat kernels, these have normally also undergone the kilning process to extend their shelf life. Just as bread should be leavened for a long time to prevent mineral deficiencies, oats should also be soaked for many hours, but be aware that the product has already been "destroyed" by heat treatment, so it is necessary to soak it with, for example, rye flakes to ensure digestibility.

The cooking time for modern oatmeal is around 3 minutes, while the cooking time for regular rolled oats is about the same as rice porridge in just under an hour. This is because the oats are steamed during the oatmeal production process. Oatmeal is not a raw grain, but a steamed grain product similar to *pre-boiled rice*.

Oats have been eaten far back in history. However, it was hardly as oatmeal. Oatmeal, as we understand it, was invented in Scotland and travelled from there to America, from where it came back to remaining parts of Europe, including Denmark. The first factory in Denmark to produce what we understand today as oatmeal was started in Maribo in 1898.

The genetics and evolutionary history of oats

Common oats are hexaploid, which means they have three sets of chromosomes. If you pull the oat's chromosomes apart and lay out the DNA in a long row, it becomes 4½ metres long and has over 100,000 genes, all in every single cell. That's 3 times as much as barley, for example.

What normally happens when two individuals are crossed is that the offspring gets half of the mother's genes and half of the father's. However, a normal cross can only occur between individuals whose chromosomes match. Occasionally, however, what is known as chromosome doubling can occur. This means that the offspring does not just get half of each parent's genome, but their entire genome. In other words, the offspring gets twice as many chromosomes as the parents had. The offspring cannot normally cross with the parents, as they do not have the same number of chromosomes, and will also differ in different ways from the parents. This creates a new species.

Common oats are the result of several more primitive oat species crossing over and forming chromosome doublings, but we're still not entirely sure which species they are.

There are around 27-31 species of oats, depending on how you define the species in relation to each other. Table 1 lists the most commonly used names. These include the original diploid species, which have only the original 7 pairs of chromosomes, tetraploid species with a double set of chromosomes, and hexaploid species with a triple set of chromosomes.

Table 1: Overview of cultivated and wild oat species.

	art	Danish name	by
1	*A. clauda*		C
2	*A. erianthaa*		
3	*A. ventricosa*		
4	*A. bruhnsiana*		
5	*A. prostrata*		A
6	*A. damascena*		
7	*A. longiglumis*		
8	*A. canariensis*		
9	***A. brevis***	Short oats	
10	*A. hispanica*		
11	*A. lusitanica*		
12	***A. nuda* (syn: *A.nudibrevis*)**	Naked oats	
13	*A. matritensis*		
14	*A. wiestii*		
15	*A. hirtula*		
16	*A. atlantica*		
17	***A. strigosa***	Pure oats	
18	***A. barbata***	Bearded oat	AB
19	*A. vaviloviana*		
20	*A. agadiriana*		
21	*A. abyssinica*	Abyssinian oats	
22	*A. maroccanab*		AC
23	*A. murphyi*		
24	*A. insularis*		CD?
25	*A. macrostachya*		AA
26	***A. fatua***	Flying oats	ACD
27	***A. occidentalis***	Sword oats	
28	*A. sterile*	Gold oats	
29	*A. ludoviciana*		
30	***A. sativa***	Common oats	
	A. sativa* ssp *nudisativa	Naked oats	
31	***A. byzantina***	Red oats	

Common oats (*Avena sativa*) are therefore hexaploid and have a triple set of chromosomes. Table 1 shows that oats have A, B and D genomes. Common oats probably originated from golden oats (*Avena sterilis*), which is a hexaploid weed. Golden oats were probably created by crossing a wild tetraploid oat species, *Avena insulata, with* another oat species.

Avena insulata, has the AD genome set, but the problem is that there are no diploid species that have genome D. It is simply not known where it comes from. Most people today believe that the D genome is actually an A genome that for some reason has been altered so that it differs from the original A genome. Either way, it is not known which diploid species is the origin of the D genome. The origin of the A genome is probably *Avena clauda*, but could also be one or more of the others. Bearded oats (*Avena barbata*) may also be involved in the development of common oats. The problem with determining the oat family tree is that the different species with the same genome can cross with each other, so when mapping the genes, fragments may appear in the genome that originate from a completely different species. At the same time, oats are not cultivated as a crop in the areas around the Mediterranean, Caspian and Black Seas where the species originated. Here, it only occurs as wild species and weeds. From here, it spread as a weed with emmer cultivation up through Europe, and only became a cereal as it travelled further north.

Oats *Avena fatua* is a wild oat species that occurs as a weed in cereal fields. Wild oats probably evolved from common oats by mutating some of the cultural traits of oats. Previously, it was believed that wild oats were a strain of cultivated oats. Great efforts are being made, especially in Denmark, to keep this weed as low as possible. It will probably never be eradicated. For one thing, most countries are not quite as hysterical as Denmark, and for another, the species will probably re-emerge from cultivated oats through spontaneous mutation.

Historical oat varieties

Abundance from Garton in England came to Denmark in the late 1800s. It has a very low shell proportion and a stiffer straw than Danish oats, but a lower yield. However, it gained some popularity as it had larger kernels than Danish oats.

Andersbecker, see *Beseler*

Beseler oats are found by selection in Provsti oats. It was introduced to Denmark in the 1880s and became widespread on the islands. It is has a higher tendency to loose grains during maturity than Danish oats, but otherwise similar.

Black Tatarian is a Sword Oat from before 1919.

Borris Stand is a cross between *Lyngby Hedehavre* and Guldregn (Golden Rain), and is thus a sister variety to *Borris no. 37.*

Borris no. 37 is a cross between *Lyngby Heath Oats* and *Golden Rain, and* is thus a sister variety to *Borris Stand*, but more similar to the grey *Lyngby Heath Oats.* It is a rather late variety of grey oat and the hull percentage is high. It was especially recommended for mixing with spring rye on sandy soil.

Brie oats are a French straw-stiff variety with short, chubby kernels. It is also called double oats because it produced two almost equally sized grains in each ear. Recommended in the agricultural encyclopaedia from 1875 for stiff soils, because on milder soils it yields more straw than grain. It has hardly been cultivated in Denmark on a large scale, but is described as a parent variety of *French Black Oats.*

Broget Oats are the same as *Grey Oats*.

Coulommier Oat is a French variety from before 1919 that had a very low percentage of hulls (22-23%), which made it interesting for oatmeal production, but yields were low and it was not widely used.

Duppau Oats are from Bohemia. It is characterised by having only a single grain in each small axis. However, it is small-grained, thick-shelled, and the yield of both straw and grain is lower than Danish oats (Madsen-Mygdal 1919).

Early Angus see *Scottish Oats*. (Madsen-Mygdal 1919).

Elkjær oats are attracted to the Pajbjerg Foundation. After *Lyngby Hedehavre, Elkjær* was the dominant variety on sandy soils, especially in Jutland.

Flueben, see *purhavre*

Flying Scotchman see *Scottish Oats*.

Fold Havre is a Svalöf cross between *Sejr* and *Ørn* from the late 1930s. They ripen a little more evenly than *Ørn* and have a larger kernel.

Førslev Oats is a *Danish Oat,* where the seed was produced at Førslevgård near Haslev

Grenå Oat is a *Hessel Oat,* which was widely used in the Grenå area.

Grey oat is both a designation for the landraces grown in the sandy areas of Jutland in the 1800s, but also a type designation for oat varieties with grey inner husk. The original grey landraces of oats are no longer preserved in, for example, the NordGen genebank, but Hansen and Christensen 1926 give an excellent description on p. 71: "*In its old form it (grey oats) contains many, rather different types of oats, including, as a rule, some ordinary white oats, usually more or less strigosa oats, and occasionally a rarer oat variety with strongly yellow grains; but the main form "grey oats" itself is composed of many different types. As a whole, it is silty with a long, soft straw that is easily damaged and is heavily attacked by rust. The top is larger and more open and more upright and versatile than Danish oats. The spikelets usually contain 2 grains. The inner grain is light grey, often clearly longitudinally striped. The outer grain is greyish-white, long-pointed, with a partially long and strong spike. The density is low, 40 to 45 kr per 100l. The emerging plants are very dark, almost black-green in colour, making it very different from most other oat varieties..... Gradually, the plants become lighter, but they retain a matt dark green colour. It is thick-shelled (approx. 35% husk). It seems to tolerate drought and cold better than most other varieties, and it also seems to overcome attacks by frit flies better.*" The fact that grey oats tolerate frit fly (*Oscinella frit*) infestation may be related to the fact that they bush more than other oat varieties.

Yellow Næsgaard was the first pure lined variety to become widespread in Denmark. It was bred by H.A.B Vestergaard at a committee in *Beseler Oats in* 1899. The kernel is bright yellow and was an improvement in straw strength compared to the old country varieties (*Dansk Havre* and *Provsti-havre*). It matured a little later than the *Danish oats,* but the kernels were very large and the yield was higher.

Guldregn (=Golden Rain) is a Swedish variety from Svalöf that is very early. It is bred from Sejr oat, but has smaller seeds and performed poorly on good soils, but better on poor soils.

Yellow-white Tystofte is a yellow oat that originated as a selection in Provsti oats. It is praised in Tidskrift for Landøkonomi in 1908, where it has some distribution in Denmark.

Hessel Oat is a *Danish Oat,* which was made at the Hessel manor house near Grenå.

Højer No. 10 was developed by Statens marskforsøg after selection in *Sort Fransk Havre,* but unlike this, *Højer No. 10 is* a white oat with a lower proportion of hulls and higher grain weight.

Højer 47/7 is a variety developed primarily for the marshlands after selection in Højer 10 around 1930. It was quite thin-shelled and had a somewhat soft straw, but yielded quite high in the trials.

Potato oat is an English variety that was mentioned in Danish trials as early as 1873 and was little cultivated until the First World War. It has predominantly single-seeded spikelets with thin-shelled grains of low bulk density.

Klokkehavre (Bell oat) is a black oat from Svalöf with a fairly high proportion of hulls. It is said to be resistant to frit flies and rust.

Short Oats are not an oat variety, but a species of oat (*Avena brevis*). It is diploid like Britle oats (*A.strigosa*), but the kernels are shorter and thicker than those of pure oats.

Kron oats came from Svalöf after selection in *Provsti oats*. It arrived in Denmark a little later than Sejr oats, and became widespread, especially in Jutland. The variety has a low shell content. Although in almost all trials it gave a higher grain yield than *Sejr*, it never gained the same distribution, which may be due to the fact that the straw yield was correspondingly lower, which was of great importance to farmers at the time.

Ligowo Oats came to Denmark from Vilmarin in France around 1890 as one of the first foreign pure-line varieties to arrive in Denmark. Although it gave a lower yield than *Danish oats* on most soils, it nevertheless gained widespread acceptance because it was more stiff-strawed and matured earlier. In addition, the kernel and density were larger, making it a better commodity than *Danish oats*.

Lyngby hedehavre was attracted to K. Hansen in 1913 by selection in *grey oats*, and quickly took over almost its entire range in the southern parts of Denmark.

Max oats, along with *Palu,* were grown on lowland soils after the shift away from black oats. The variety is a cross between *Minor* and *Abed 30*.

Minor is a cross between *Sølv (Silver)* and *Black French Oats* from around 1940. The variety has very chubby grains and was especially recommended for cultivation in raised bogs.

New Zealand oats are mentioned as early as 1893 as a very early oat with beautiful white, albeit somewhat thin, thick-shelled grains with a very high density. It is suitable for cultivation on marshland. The yield is characterised as low.

Nova oat is a variety selected from *Provsti*. It is the parent variety of the more well-known *Sølv oats*.

Opus oats is a selection in Borris Stand from 1945. It was one of the highest yielding varieties after the war. In 1948, an improved version was released on the market, which came to be called Opus *II*. The kernel is surrounded by very thin husks that fall off very easily.

Palu oats are a yellow oat that, along with *Max oats,* were grown on lowland soils after the shift away from growing *black oats*. *Palu oats* are a cross between *Minor oats* and *Eagle* from 1945

Purhavre (=*Britle oat or sand* oats) is not an oat variety, but a separate oat species (*Avena strigosa*). In the past, it has been grown on very sandy soils in western Jutland, either as a pure stand or in a mixture with regular oats, especially grey oats. Pure oats have a high shell content, approx. 33%, low bulk density and low grain yield, but have a high straw yield. In America, it has begun to be cultivated for green fodder in some places due to the plant's frugality and high yield of green mass. In English it is called 'lopsided oat' or 'black oat', but for this reason it should not be confused with what we call *black oats in* Danish.

Rex Oats is a cross between *Eagle* and *Manholt's Binder* from 1948. The variety is straw stiff.

Red oats are not an oat variety, but a separate species of oat (*Avena byzantina*), of which there are several varieties. *Red oats are* mostly grown in southern climes and in America and Australia. Red *oats* have reddish-brown grains that are often larger than those of our own oat varieties, but whether the size is due to climatic or varietal differences is uncertain. The proportion of hulls is larger in red oats than in regular oats, which is why the feed value is lower.

Schlanstedt-Havre comes from the Schlanstedt estate in Germany from before 1919. Like *Gul Næsgaard,* it is a variety developed from a selection in *Beseler Havre*. Schlanstedt *Oat* has a very coarse and stiff straw, and at the time it gave the highest straw yield. It matured slightly later than *Gul Næsgaard.*

Sejr Oats (Seger in Swedish and Victory in English) was developed by Svalöf by selection in the American variety *Milton* around 1908-9. It became the most cultivated variety in Denmark, and in 1925 accounted for 79% of the oat area on the islands and 56% of the oat area in Jutland. The variety is medium early and has a high bulk density.

Black oats are not an oat variety, but a term for the oat varieties that have black inner husk. Black oats contain more antioxidants than white and yellow oats. It is generally said that the old varieties of black oats had a higher proportion of hulls than yellow oats and that digestibility is better due to the protein composition. However, it should be noted that the black colour is only in the inner chaff and that the inheritance of the black chaff colour is relatively simple. It is probably only controlled by a single gene. The other characteristics attributed to black oats are not controlled by this gene. Thus, there is nothing to prevent crossing and backcrossing from transferring the black inner oat colour trait to a yellow oat variety without transferring other traits. For example, the old varieties of black oats had a reputation for being straw stiff, but this characteristic has been transferred to yellow oat varieties through crossing. It is mentioned in an agricultural encyclopaedia from 1875 that horses prefer black oats to white oats, and black oats have been recommended for horse feed in more recent times. According to the historical descriptions, it makes sense to use the old varieties of black oats as horse feed, but whether the recommendation only applies to the old varieties or whether the recommendation is related to the black inner name is unknown.

Black French Oat is a cross between *Brie* and *Ligowo* and was introduced to Denmark in 1927. Compared to the yellow and white varieties, it is very stiff-stemmed and matures earlier than the yellow and white varieties. The variety has a poor bushiness, and the seed rate must therefore be quite high. The skin percentage is quite high, around 29-30%. This is somewhat higher than white and yellow oats, but on the other hand, the fat content is higher, which means that the feed value is about the same. It was especially cultivated on marshland, both because it is quite stiff and because it tolerates manganese deficiency, which is often a problem on marshland, better than other varieties.

Stand Oats from Borris is a cross between *Lyngby Hedehavre* and *Guldregn*. Thus, the variety is a relatively frugal oat that has performed well on sandy soil, but unlike the grey *Lyngby oat,* the core colour is yellow and the straw is stiff. On the other hand, the bulk density is low due to a high proportion of hulls.

Star Oats is a slightly confusing name because there are two different varieties called *Star Oats*. One, *Star Oats,* is a selection of *Provsti Oats* that was made in Tystofte in the early 1920s. It is slightly earlier than *Eagle,* and although it is more soft-strawed and had a lower straw yield, it gained some popularity. The other *Star Oat* is a cross between *Guldregn* (or *Kron*) and *Sejr* from Svalöf from 1927. In Sweden it is called *Stjärn.* It is quite stiff-stemmed.

Stormogul is a pre-1919 Svalöf black oat from Svalöf with a fairly high proportion of shell. The variety is very tall. In 2007, I measured it up to 180 cm.

Stål (Steel) were the dominant variety in Denmark along with *Eagle*. In 1964, *Stål* oats were grown on 75-90% of the oat area. Stål is from Sweden, where it is called *Sol II*, and is a cross between *Stjerne* and *Ørn*.

Sword oats (=*comb* oats, *Fane oats*) is a collective term for oat varieties where all the small spikes face the same side. It is often referred to as a separate species (*Avena orientalis*). Sword oats are available in black, yellow and white forms.

Sølv (Silver) oats came from the Danish breeding station Abed in 1923 after crossing *Gul Næsgaard* and *Nova Abed*. Silver *oats* have a very large and distinctive white centre. In 1931, Abed released a new version of the *Silver oat* called *Silver II*. It has slightly shorter and stronger straw than the original *Silver Oat*.

Thurebyholm is a *Danish Oat*, which was made at Thurebyholm.

Trifolium oats were cultivated a lot around 1908. It is very similar to *Ligowo oats.*

Ø (Island) Oats are believed to be the same as *Førslev Oats*.

Eagle oat is a Swedish variety that emerged around 1930. It is a cross between the German variety *Lochows Gelbhafer* and *Sejr, and* from the start it was far superior in yield to the other yellow oats. It quickly became the dominant variety in Denmark, both on clay soils and on the best sandy soils. It is quite short-strawed with a small kernel, but with a low proportion of husk. Farmers were pleased with the high yield of the *Eagle oat*, but the roll mills that made oatmeal were not enthusiastic about the small kernel.

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