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The Landrace

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Index

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Looking back at 2023

The varieties from Landsorten's catalogue are increasingly being cultivated and used in Northern Europe, and around 15% of the organic milling wheat area in Denmark is currently cultivated with varieties from Landsorten. Popkorn and Mariagertoba accounts for the vast majority of the area. Danish Spelt and, to a lesser extent, E3 spelt are also increasingly replacing foreign spelt varieties such as Oberkulmer Rotkorn. It is confirming to see that almost all organic Danish mills now support the association and continue to increase their acreage.

In 2023, we have again experienced the gradually more unstable climate that we are looking into in the future. Many farmers, especially on the clay soils of Zealand, had to postpone sowing in the spring due to the heavy rain in March and April, and after sowing started in May, there was a drought with poor germination and growth. When the rain finally returned at the end of June, it wouldn't stop. This meant that spring wheat, spring barley, etc. began to forcibly ripen in the drought and yet began to grow again in July, resulting in uneven ripening. As it continued to rain throughout the harvest, many crops lost quality.

This is not meant to be a continued list of lamentations about the difficult conditions for farmers. On the contrary, we must learn from experience and think ahead. Firstly, it hasn't actually been a bad year for agriculture in terms of cultivation. It has been poor for some farmers with a lot of spring-sown grain, while it has been a very good year for farmers with a lot of maize and clover grass, who benefited from the heavy rain in the warmest months and a warm autumn, so farms with these crops have harvested well this year. You just don't hear much about that. The conclusion is also that we will probably never experience a year like this again. Not that next year and the future will be better, quite the contrary, but it will probably be extreme and unpredictable in a new and different way every year, so next year it might be good to grow spring wheat and bad to grow maize. Nobody knows.

So what does a more unpredictable climate mean for Landsorten and its members? It means investing even more in diversity, because that's the only way to spread the risk. Many different crops and high diversity within each crop. This is certainly one of the answers to climate adaptation of the future.

The little chloropid gout fly (Chlorops pumilionis)

Once again this year, there have been major problems with the chloropid gout fly (*Chlorops pumilionis*) in spring wheat. Many growers have therefore started sowing spring wheat in the autumn as if it was winter wheat, and the spring wheat has done well through the winter because it has been mild. On the other hand, it has been difficult to get enough protein in the winter-sown crops to achieve optimal baking quality. Even the autumn-sown Mariagertoba, which otherwise has a higher protein content than normal winter wheat, has in some places fallen short in terms of baking quality, unless it has been given plenty of livestock manure. I think that more farmers with low fertiliser levels could benefit from increasing the row distance to 30cm and row harrow the crop to increase the protein content. It costs a little in yield and it is more labour-intensive with row harrowing, but it should be compensated by a better payment for the higher protein content. Everyone promoting local production of quality grain should be able to agree on a pricing model that honours good quality.

To improve the quality of milling grain in a situation where spring wheat is threatened by the chloropid gout fly, Landsorten is also trying to breed the winter wheat variety Fitnisse, which is similar to Popkorn but with a higher protein content. We believe that Fitnisse could be a good alternative to growing winter-sown spring wheat, as it will be more winter hardy in the event of a severe winter, while providing a protein content and gluten quality comparable to Mariagertoba.

Unfortunately, the available quantities of Fitnisse are very limited, so in 2024 there will still only be enough seed for a small part of the expected demand.

The big problem in bread grain in 2023 has been the drop rate. When it rains a lot during the harvest, the grain starts to sprout in the ear, which breaks down the starch into sugar, ruining the baking quality. In 2023, the vast majority of bread grain has a lower than normal falling number than normal, and it has been difficult for mills to obtain both rye and wheat with a sufficiently high falling number. Fortunately, a low falling number will not affect the germination quality of the grain, so some of the rejected bread grain has been used as seed. Together with the mills, the farmers have swapped grain back and forth, so that grain with a good falling number is prioritised for flour and low falling number for seed. This is the best we could do in the given situation.

Gl. Buurholt has, as described in the May issue of The Landrace, invested in Insight® equipment from BoMill, which can sort grain based on analyses of each individual kernels. The equipment is actually designed to sort the grain according to its protein content, but it has turned out that in some cases, sorting by protein also has a positive effect on Hagbergs Falling Number. It's not a miracle cure that can solve all problems in all seed lots, but the preliminary trials have shown that in some batches you can increase the Hagbergs Falling Number. In some batches, you can increase the Falling Number a lot by simply rejecting a small proportion of the grain, while in other batches you can achieve little or no effect even if you reject a very large proportion of the grain. It all depends on how uniform the batch is and what is causing the problem in each batch. For now, a test analysis of each batch is necessary to determine whether the new equipment can solve the problem or not. You can read a more detailed Danish text on Falling Number here.

Many growers have limited experience with seed production, so making their own seed, and perhaps even starting to sell seed to others, is a new professional challenge for many. Keeping varieties pure is especially difficult. When the combine arrives, it often has to be done quickly, and it is difficult to convince a contractor to spend 6-8 hours in the middle of a busy harvest to clean the combine between two different crops. In many places, wheat becomes contaminated with rye because the combine is not adequately cleaned between fields. This is not a problem when the grain is only used for feed or milling grain, but it's not acceptable for sowing seeds. Therefore, there is a need for extra focus on the fact that special procedures are needed to ensure cleanliness. This has been one of the key lessons learnt with the Landsorten seed system from the year. Furthermore, it cannot be said often enough that organic farmers should never buy or sow wheat without checking the seed for common bunt. There are still far too many batches that become infected because the seed has not been checked, and once one crop is infected, the combine harvester and other equipment will make sure that the infection spreads to the rest of the farm and the farms with which it cooperates.

Staff situation in Landsorten

In 2023, Bjarne Hansen and Johan Lund have worked to coordinate seed production and have helped growers and producers obtain the seeds and varieties they require. In this connection, they have also visited many members to advise on seed quality, among other things. It is in the interest of both growers and Landsorten that the seed system works optimally, and gathering experience has been a highly prioritised goal for Landsorten in 2023. We can conclude that there is a great need for this kind of knowledge sharing. From February, Johan will resume his education and will therefore work on reduced hours in 2024. In 2024, Bjarne will therefore primarily be responsible for the coordination of seeds.

Lone Andreasen, who has been responsible for the daily management and administrative management of Landsorten since the association was established, wishes to retire and make room for new forces after many years of faithful service to organic farming in Denmark. Lone has been a

driving force in getting Landsorten on its feet and developing it to where we are today. We owe Lone a big thank you!

Landsorten is now in a situation where a new employee is needed to supplement Bjarne and take over Lone's work on developing the organisation. A position will be advertised during December.

JOB POSTINGS

Become a development officer in Landsorten

The main task of the position is to further develop Landsorten and support the organisation's growth in collaboration with the other employees. This involves, among other things:

- Spreading awareness of the organisation and the varieties
- Making development plans and implementing them
- Contact with current and potential members
- Participating in the prioritisation of varietal characteristics in current and future varieties

In addition, there are also tasks related to the association's regular operations such as budgeting, accounting and project administration.

The tasks can be customised and distributed depending on the employee's profile, and there is ample opportunity to shape the tasks according to your own wishes. The work will take place in close collaboration with plant breeder Anders Borgen and seed coordinators Johan Siboni Lund and Bjarne Hansen.

We are looking for someone who is outgoing and not afraid to make the first contact for a potential new collaboration. It is an advantage to be structured, as you will help keep an overview of the organisation's activities. You must have the courage to work independently, but you will be part of a team where joint decisions are also important.

We offer a dynamic working environment characterised by commitment, high professionalism and job satisfaction. The structure of the organisation is based on employee participation, where employees, the board and members of the organisation can come up with ideas and input that are taken seriously. You'll have the opportunity to be at the centre of the development process in a growing company, where you'll be able to develop ideas, put them into practice and follow them through in collaboration with other employees. There will be a training and handover period that is customised to the employee's wishes and needs.

The starting point for the position is 30 hours/week and there are good opportunities for working from home. Currently, we work partly from home and partly in Mariager. However, we will soon find shared office space in East Jutland, depending on the wishes of the applicant and the other employees. We'll figure this out together.

Salary according to qualifications and start date 1 March or by agreement.

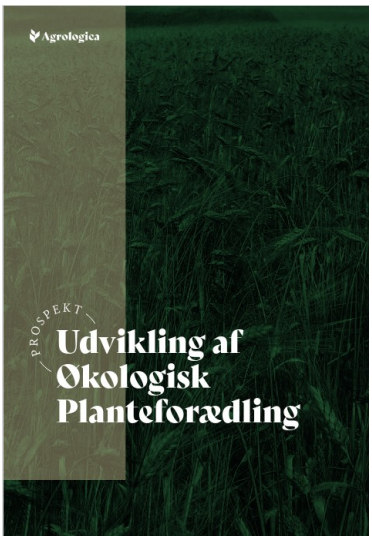
You are welcome to call and hear more about the position: Anders Borgen 40813518 or Johan Siboni Lund 42716276

Send your application to borgen@landsorten.dk no later than 31-12-2023

Become a miller on Funen

Økomølleriet on Funen is looking for a dedicated employee to run the stone mill. Kristian Andersen, together with his other employees, has been running the mill at Kragegården near Ringe since 2007 with a wide range of grain varieties from Landsorten and other speciality varieties. Contact @Kristian: +45 20812071

Plans for an organic plant breeding station



There is no organic plant breeding in Denmark apart from Agrologica. This is a fundamental problem that stands in the way of the continued development of organic farming in Denmark. That's why we are a group working to establish an actual organic plant breeding centre. We have ambitions to expand Agrologica with better facilities, more employees and work with more crops. This requires investment, and we hope that the breeding station will be broadly based in the organic movement, preferably with companies and individuals with either soil or dough on their fingers. We have calculated that with an investment of DKK 13 million, we will be able to establish a profitable business model with processing of vegetables, pulses and grains in a well-functioning professional environment. We are also considering the purchase of real estate so that the physical facilities can be included in the establishment phase if we succeed in raising the necessary capital.

With support from the Foundation for Organic Agriculture, we have prepared a prospectus describing the project with budgets, market analyses and other assessments of the potential.

If you have investment potential, you have the opportunity for a long-term green investment to benefit the development of organic farming and plant-based foods. Please contact us to receive a prospectus about the investment opportunities and share it in your network.

Status for common bunt research

Few farmers and even fewer consumers know about common bunt. Thank goodness for that. But behind the scenes, common bunt is a huge problem. 90% of all conventional seeds are treated with fungicides that are specially developed to slowly degrade in soil. A half-life of around 4 years is common in modern seed treatment pesticides, causing toxins to build up in the soil, harming microlife and therefore biodiversity. Common bunt also poses a serious problem for pesticide free and organic wheat production around the world, because without fungicide treatment, many seed lots of wheat need to be discarded every year. If all varieties were fully resistant, the problem would be solved in both conventional and organic farming. That's why Agrologica is working in both the BOOST and DIVERSILIENCE projects to develop varieties with better resistance. The challenge is that it is very labour-intensive to test for resistance, and it is also very difficult to predict which resistant varieties have the most stable resistance, as it depends on which resistance gene(s) the variety has and which common bunt races the variety is at risk of being exposed to in the future. Therefore, Dennis Christensen and I are working in collaboration with a number of American and

European breeders and universities on 1) developing genetic markers for resistance, so that we can know exactly which resistance genes the variety contains based on a DNA analysis, and 2) investigating which patho-type races in Europe have an effect on which resistance genes.

In variety selection and breeding, Landsorten and Agrologica works as far as possible with populations and mixtures rather than pure line varieties, as, all other things being equal, this provides stability in cultivation in relation to quality, plant diseases and other challenges. Agrologica is therefore also working on documenting how population cultivation affects the stability of resistance to common bunt, as this has not previously been studied.

I work mostly with the field trials and deliver data from them to Dennis Christensen, who does the statistical and detailed genetic analyses. This has proved to be a very fruitful division of labour. The results have been very positive, and even more positive than we had hoped for at the start of the projects. From the beginning of the 20th century until 2012, 16 different resistance genes had been identified, and that was our starting point. Our analyses have shown that there are far more than 16 common bunt resistance genes, and we have so far identified 39 of them, which will make it easier to find new combinations to build full resistance. At the start of the project, only some imprecise genetic markers had been developed for two of the resistance genes, namely Bt9 and Bt10. During the project, we have succeeded in developing much more precise genetic markers against 25 of the resistance genes. Thus, it is now possible to breed fully resistant varieties using genetic markers alone, if some of the 12 resistance genes with the most precise markers are used.

A **genetic marker** is an easy-to-find location on the genetic DNA code that is somehow linked to a gene. Even if you don't know the details of the gene itself, a marker can still predict with some degree of probability whether a plant has a resistance gene or not. In other words, it's a genetic fingerprint in the same way that humans can submit DNA to a laboratory that can tell if we have a hereditary disease or have been involved in a crime. In the last decade, genetic markers have increasingly become important tools in plant breeding to provide information about the characteristics of varieties.

We have tested 44 different spore samples of common bunt from Europe, and tested their virulence to the bunt resistance genes. Unfortunately, it was found that virulence exists against almost all resistance genes. This means that none of the resistance genes can provide 100% safety against attack if used individually, but by using the genetic markers, it will be possible to combine several genes into each variety and thus achieve resistance with 100% safety against attack.

The studies of the effect of mixtures on the effect on common bunt infestation have shown that there do not seem to be significant synergistic effects of the mixtures. This means that it is still the varieties' own resistance that is important in avoiding common bunt. However, it will still be an advantage to combine effective resistance genes with mixtures, as the mixtures will, all other things being equal, limit the rate of common bunt propagation in a population, but only that this limitation appears to be linearly proportional to virulence, and not exponentially progressive as hoped.

Landsorten has varieties both with and without resistance to common bunt, and the resistant varieties and populations have resistance that is not 100% effective. Especially the conservation varieties are typically susceptible to common bunt, but there may also be some of the new varieties that have special characteristics and where resistance to common bunt has been compromised. Only Popkorn has a combination of many different resistance genes, and these are a mix of highly effective and less effective genes. In practice, there have been no serious infestations in Popcorn so far, and the fact that the less effective genes are only found in limited frequency in the mixture means that the risk of infestation is low. Most other varieties and mixtures either have no resistance or are based on a single gene. For example, Mariagertoba is a mixture of lines that all share the same resistance gene, Bt7, against which there is widespread virulence in Europe and also in Denmark. This means that testing for common bunt infestations must continue in all seed lots, as there is still a risk of infestation in the resistant varieties as well.

The fact that infestations can occur in resistant varieties does not mean that it doesn't matter whether a variety is resistant or not. Resistance in a variety means that the risk of infestation is significantly reduced compared to susceptible varieties, but IF the variety is infected by one of the rare virulent strains, infestation can still occur. It's a bit like a flu vaccine that protects against the most common strains of the virus, but doesn't protect against all of them. For Landsorten's strategy, this means that it will be advantageous to use the genetic markers to develop new varieties with better resistance that can eventually replace Landsorten's current range of varieties. Until this is done, there will still be a need to test all seed lots for common bunt and either discard infected lots or treat them with vinegar, brushing or other methods that can minimise infestation.

The tiny village Voel has apparently chosen a bunt spore as their town logo

In many contexts, ecology works towards self-regulating systems based on biodiversity. This means that weeds must be controlled sufficiently for the farmer to be able to harvest a reasonable yield, but that there should be some wild plants in the agricultural system that, for example, provide food for beneficial insects. It is simply not an advantage, even for the farmer, to control weeds 100%, as a landscape without beneficial insects provides better conditions for pests. Fungal diseases must also be controlled to a certain extent, but it is not desirable to eliminate all fungi, as a biological vacuum in the absence of fungi will make it easier for pathogens to multiply. This is why organic farmers will not use pesticides, as they are simply too effective at eliminating fungi and wild plants to the detriment of microlife, soil fertility and the self-regulating ability of the cropping system. It would also be ideal to keep common bunt down to a level where it didn't harm the quality of grain, but the damage threshold for common bunt in relation to quality is so low that in practice it is close to the detection limit. If you can measure the presence of common bunt spores, it's almost the same as the quality of the grain already being compromised. In practice, common bunt propagates by a factor of 100 every year in susceptible varieties without control. This means that control and resistance together must be able to limit the multiplication by 99% in order for the quality of the harvested product to remain at the same level as the seed. Therefore, the goal of keeping common bunt at an acceptably low level is in practice the same as saying that common bunt must either not be detectable in the seed at all, or that they must be controlled with close to 100% efficiency.

For those who are interested, you can watch or re-watch a webinar on common bunt management with a focus on resistance and genetic markers here.

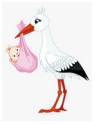
How food additive may trigger gluten allergy

There is an increasing prevalence of gluten allergy worldwide, and also of celiac disease, the most severe form of gluten intolerance. Coeliac disease occurs when protein, especially from the gliadin in gluten, is altered by transglutaminase in the intestine. When the protein code in the gluten peptide QPFPQP-**Q**-LPYPQPQQ is deaminated by the body's transglutaminase to QPFPQP-**E**-LPYPQPQQ, the immune system of some patients reacts autoimmune. This causes the body's own immune system to start breaking down the intestinal wall with serious and sometimes fatal consequences. The only known treatment for celiac disease is to avoid gluten-containing foods.

Although the mechanism of celiac disease is well known, it is more difficult to explain why there has been such a dramatic increase in the prevalence of celiac disease in recent decades. I've

previously described various theories in The Landrace (May 2022), particularly regarding the importance of long rising times for bread fermentation because it helps to break down some of the proteins that cause problems, but there may be other explanations as well.

The increase of coeliac disease in society has coincided with an increase in the use of food additives. Now, just because some things happen at the same time doesn't necessarily mean that there is a cause-and-effect relationship. There has been a decline in the number of storks over the last 50 years at the same time as the number of births has fallen, but you can't conclude from this whether the birth rate has fallen due to a lack of storks or whether the storks have disappeared because they have become unemployed as suppliers of babies. Some sceptics might even argue that it could also just be a coincidence. Similarly, there is not necessarily a correlation between the use of food additives and the development of coeliac disease. However, the reason why some people suspect a link is because there is a chemical explanation that supports the linkage.



One of the additives commonly used in industrial food processing is bacterial transglutaminase. It is an enzyme that is very similar to the transglutaminase that the body develops in celiac disease, but the enzyme is simply developed by bacteria and refined in industrial bioreactors. The EU has decided that the addition of enzymes in food processing does not have to be declared on food products, so you can't tell from a processed product whether or not enzymes have been used in production. The reason why enzymes do not have to be declared in the list of ingredients on an equal footing with other additives is that enzymes are generally inactivated by heating and are therefore no longer chemically active in the product when it reaches the consumer. The problem with bacterial transglutaminase is that it is not the enzyme itself that is the problem, but rather the enzyme's alteration of the protein structure of the food that may be causing the problem.

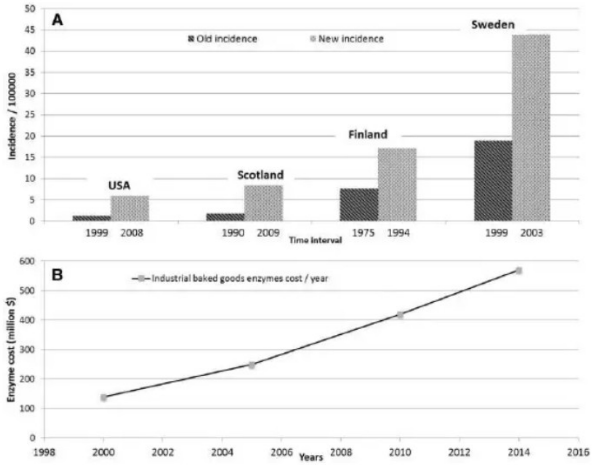


Figure 1 **(A) The change in celiac disease incidence over time in different countries, and (B) the direct correlation between the increase in celiac disease incidence and the increased annual expenditures on food-processing enzymes in the food and commercial baking industries in Western countries.** Adapted from references[7,8,15,16,73–76].

Bacterial transglutaminase is used throughout the food industry and in virtually all industrially produced bread products. The enzyme creates bonds between proteins, making bread dough firmer. Ordinary cheap standard flour becomes hocus pocus flour with good baking quality, and an industrial bake-off product will look like am artesian sourdough-raised beauty on Instagram baked on stone-grinded Mariagertoba flour. The consumer doesn't realise anything, but is simply delighted by the price, because the artificial enzymatic modification is not declared in the ingredient list. Only the statisticians at the National Board of Health can sit back and wonder why the number of coeliac patients continues to rise.

Patents and GMOs in organic production?

The EU is currently revising seed legislation, the organic regulation and the environmental regulation of genetically modified organisms, including GMO plant varieties. One of the reasons for this is that a number of new plant breeding techniques (NBTs) have emerged that were not available when the rules for genetic engineering were adopted. The question arises whether they should all be regulated by the same rules or whether there is a need to adapt the rules to the new methods.

Patents or plant variety protection

There is a crucial difference between the use of patenting and plant variety protection when protecting plant varieties. Plant varyety protection is the common protection applied to the majority of plant varieties grown in the EU. The plant breeder is given the right to charge a royalty for up to 25 years to those who grow the variety. It's as simple as that. Once the farmer has paid the royalty, he can use the crop for whatever he wants. You can sell the grain to the mill of your choice, or use it to cross with another variety to create a completely new variety. You can do this with varieties despite the plant variety protection. Patented varieties, on the other hand, are different. If a variety is patented, the owner of the patent actually owns it and can decide everything about both the variety and all the products developed from the variety. If you have a patent on a variety, you can prevent others from using the variety for crossing and developing new varieties, and you can decide which companies can buy the agricultural products and foodstuffs produced from the variety. Therefore, bit multinational companies are enthusiastic about patents on varieties because it gives them full control over the entire food system, while small plant breeders are usually opposed to patents on plant varieties because otherwise they cannot access the genetic material they need for breeding.

In the US, China, South America and many other places, far more genetically modified plants are grown than in the EU. There are several reasons for this. Perhaps the most important is that European plant variety protection is quite restrictive and effective. In practice, it is very difficult and expensive to get a common plant variety authorised for cultivation in the EU, but on the other hand, if you manage, the protection of plant breeders' rights is quite good. Plant variety protection has therefore been sufficient for European breeders to make plant breeding profitable, and European breeders have therefore had less need to patent varieties, which is a much more restrictive form of protection. In principle, a plant variety cannot be patented at all, so in practice, patenting plant varieties can only be done by patenting the breeding technique used to develop the variety. This is why some companies use genetic engineering techniques in breeding, partly (and perhaps mainly) to be able to patent their varieties. This is one of the reasons why genetic engineering of plants is not as widespread in the EU, because in the EU it has simply not been necessary to patent varieties to make plant breeding profitable.

Traditional and untraditional plant breeding

Plants and all life in nature evolve through the occasional random mutation, which are small errors in the genetic material, DNA. The errors occur when radioactive radiation from space or the earth hits the DNA strain in a germ cell or when the cells are exposed to chemical influences. We try to protect ourselves from radioactivity and cancer-causing and mutation-causing chemicals as best we can, but it can't be completely avoided, and thankfully so, because we need a little bit of it to keep evolution on Earth from stalling. However, there's probably no risk of that. When a mutation occurs, it means that some gene has broken down and therefore no longer works as it should. All cultivated

plants have evolved and developed from wild plants by removing some of the characteristics of the wild plants through mutations. No new genes have been inserted into common cultivated plants. All the genes in cultivated plants are also found in wild ancestors, but not all the genes in those ancestors are still active in cultivated plants.

Plant breeding means trying to speed up the process in various ways by applying extra selection pressure to develop new varieties with certain selected characteristics. Instead of waiting 10,000 years for a new mutation to occur and switch off an unwanted gene, conventional breeding can increase the frequency of mutations and thus get rid of the unwanted gene. This can be done, for example, by increasing the radioactivity in the vicinity of the plants or exposing them to chemicals. If this is done, a number of other changes will also occur, as would also be the case if it happened in nature from the normal background radiation or naturally occurring chemicals.

The current regulation of breeding methods was adopted in 2001, when there were not many methods available. At that time, it was decided that some techniques, such as the transfer of genes from one species to another, would be regulated very rigid, while common mutagenesis, where mutations are simply induced with chemicals or radiation, would not be regulated at all. Cell fusion, as it is known from CMS hybrids, would also not be regulated, even though it is defined as GMO and is not allowed under biodynamic regulations, and a number of organic regulations in several countries prohibit the use of CMS hybrids in organic production. In Denmark, we follow the EU's minimum rules, so since it is not banned in organic production by EU, it is automatically allowed in the Danish organic regulations.

Mutagenesis, where the number of mutations is artificially increased by radioactivity or chemical action, is not to be regulated in the EU, but in principle cannot be used in organic breeding. However, organic farmers and food companies are allowed to use varieties from conventional breeding where the techniques have been applied, and organic plant breeders are also allowed to use these varieties as parents for crosses in the breeding of new organic varieties. It may sound a bit inconsistent, but the reality is that whether a mutation is caused by naturally occurring Radon in the soil or is caused by a plant breeder increasing the amount of Radon in the vicinity of his plants and thus increasing the occurrence of mutations, it doesn't make much difference in practice, and it will never be possible to distinguish between mutations caused in one way or another. As an organic plant breeder, I know which techniques I use myself, but I have no way of knowing whether the parents of my crosses or their parents are developed in one way or another, and one usually refrains from legislating something that cannot be controlled. CMS hybrids could be controlled, but it was decided that the technology has been used for so long and is so widespread that they didn't want to ban it back in 2001 when the regulations were passed. Today, F1 hybrids are widely used in both Danish organic and conventional agriculture, and it is probably more than 90% of all Danish organic cabbage today that are F1 hybrid varieties produced directly or indirectly from CMS hybrids, which in principle is defined as a GMO techniques, but one that are accepted without regulation.

New Breeding Technologies (NBT)

Since the current GMO legislation was adopted in 2001, new techniques have emerged that were not known at the time when it was decided which techniques should be strictly regulated and which could be used without regulation. Therefore, the EU wants to revise the legislation and, in doing so, consider the regulation of the various techniques.

The most well-known of the new breeding methods is CRISPR-CAS, but there are several different techniques behind the name. The EU has proposed that they should not be treated uniformly, but that each technique should be treated differently depending on what they do.

With CRISPR, it is now possible to do several new things. Firstly, what is known as NBT-1 makes it possible to design a specific chemical that induces a specific mutation in, for example, a plant. This means that instead of using a primitive mutagenic chemical that generally causes a lot of random mutations, you can determine where in the plant's DNA the mutation occurs. This is really smart if you know which gene you want to switch off. Some people think it's a bit too smart, because there are many genes that we don't know much about, so if you take a gene out of the game, it can still have surprising effects (off-taken effects).

When a mutation occurs, whether it's a CRISPR mutation or any other mutation, the DNA is damaged and the plant will try to repair the damage. Either the DNA is successfully restored intact, or it is reassembled incorrectly and a mutation has occurred. With the technique, called NBT-2, you can ensure that the induced mutation is repaired in the desired way.

With NBT-3, CRISPR also makes it possible to change the entire structure of the DNA. You can simply write a completely new code in the DNA and in this way insert completely new characteristics into the cultivated plants that are not found in the original wild species, just as with traditional genetic engineering it is possible to move a gene from a fish or a bacterium into a plant. With this part of CRISPR, it is in principle possible to design completely new traits that do not exist in other existing species.

The political question in this context is how these different new techniques should be regulated. There is little doubt that NBT-3 is a pure GMO on a par with traditional genetic engineering and that an environmental and health impact assessment must be carried out to determine whether the new traits have unintended effects. Most people agree on that. But what about a mutation induced by NBT-1? Is it considered a mutation in the same way as a traditional mutagenesis induced by a chemical that produces random mutations, or is it considered a genetic engineering because it is targeted using the new techniques? It's a truly divisive question that has stirred up emotions in the organic movement. Both because some have strong feelings against GMO, or great fear of the consequences of all forms of GMO. Others have great fear that a ban on its use in organic farming will make it very expensive to control, and at the same time make it impossible to develop new varieties for organic farming, when all conventional varieties in the future are expected to be produced with techniques that are not allowed in organic products.

Because I'm an organic plant breeder, many people ask me what I think about the topic. To be honest, I still have my doubts. In general, I don't believe that the world is a better place just because we have access to a new technology, in plant breeding or in any other industry. Before the mobile phone was invented, I didn't walk around unhappy about not having one, but now that it's available, I use it and would probably miss it if I no longer had it, but I do so well knowing that it hasn't made me any happier or less happy. Similarly, I accept the use of common mutagenesis in plant breeding, and I also some times eat organic cabbages made from CMS bred F1 hybrids if I cannot avoid it, even though these are not techniques that have grown up in my backyard. I don't like the technique and would like to avoid it, but I live with it. Similarly, NBT-1 and NBT-2 are techniques that I'm not passionate about allowing in organic use, but my world won't fall apart if they are allowed. I'm an old hippie who thinks the world is going in the wrong direction, and NBT-1 and NBT-2, along with mobile phones and CMS hybrids, will speed things up a bit more in the wrong direction, but compared to the climate crisis and the destruction of the marine environment with eutrophication, which organic farming also contribute to, I honestly think that opposing NBT-1 and -2 is to prioritise the forces against the evils of the world wrong. When organic farming compromise on attitudes, it's because it has to be seen in the light of the consequences of not doing so. Organic is a compromise all the way through. The compromises are accepted because it improves the economy and thus competitiveness compared to conventional production. If organic farming is too far ahead, production will be too small and too expensive, and more conventional agriculture will be cultivated to the detriment of nature. It's a constant balancing act. I may be an extremist in terms of

what I want, but I'm not a fanatic in terms of the compromises I'm willing to make. That's why I'm both opposed to new technologies, but at the same time I want to accept them.

My attitude towards the new techniques is probably coloured by the fact that I work with genetic markers on a daily basis and am therefore used to looking at DNA information, even though I am not involved in changing it. But it is not the industry that should make the rules for the industry, and it is not agriculture that should regulate the environmental rules for agriculture. That would be a recipe for disaster. Therefore, as a plant breeder, it is not my job to determine the rules for organic plant breeding. Give me some rules, and I will follow them.

Trademark registration of Mariagertoba®

The work of Landsorten and Agrologica's plant breeding is based on a trust that all users of the varieties contribute to the organisation's work in order for it to be financially viable. So far, it has not been a problem to secure support for Landsorten's work. Almost all organic mills in Denmark support and are members of Landsorten, and the impression is that the cultivation of Landsorten's varieties is largely limited to members. However, as cultivation becomes more widespread, it is expected that it will become increasingly difficult to secure solidarity regarding support for the work. Mariagertoba® is not only grown in Denmark, but now also in England, Norway, the Netherlands, Belgium and Germany, and it is not certain that the current business model can be maintained if the cultivation spread and volume continues to increase.

Popcorn, Mariagertoba and other varieties and populations from Landsorten cannot be patented or protected by plant variety rights like ordinary varieties from conventional breeding. Nevertheless, we believe that it would be unfair to paying members if grain from Landsorten varieties is widely grown or sold by farmers and mills that do not contribute to the work of breeding and maintaining the varieties. To future-proof the system, we have therefore registered the name Mariagertoba® as a trademark instead. All members of Landsorten can grow, process and sell the grain and use the name Mariagertoba®, while this will be prohibited for non-members. The system will remain trust-based and trademark protection will only be enforced as an absolute last resort. We hope it won't be necessary.

Marketing platform for grain

Landsorten has started working on an online marketplace. It will not be a traditional webshop where you can buy products, but rather a portal that facilitates the buying and selling of seeds, milling- and malting grains and other products of interest to Landsorten's members. It will be located on Landsorten's website under Marketplace.

Contract production of milling grain

Until the Marketplace is fully up and running online, we can inform you that several mills in both eastern and western Denmark are looking for farmers who want to sign a contract for the delivery of milling grain. Currently, there is a shortage of growers for a minimum of 200 hectares of spring wheat. If you have the lust and opportunity to grow one of Landsorten's varieties, but would prefer to have a contract for sales before you sow, Johan can put you in touch with interested mills: johan@landsorten.dk / (+45) 42716276. If you need growers for the production of bread grain or

something else, let us know, and we can also help you make contact in the other direction. That's what Landsorten is for, among other things.

Seed for spring sowing 2024

More and more farmers are starting to sow spring wheat in the autumn to avoid the chloropid gout fly (*Chlorops pumilionis*) in spring wheat. 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.

Mariagertoba

Mariagertoba is the most widely grown in the Landsorten programme and the one we recommend as the standard wheat. It achieves a higher gluten content and better quality than other varieties on the market, and is recognised by the leading bread nerds on social media. There is currently plenty of seed left of this variety and, as mentioned above, it is possible to contract the production to ensure the sale after harvest.

Ella

Ella is a Swedish spring wheat from 1948 with great baking quality. If you want to grow or bake with an old wheat variety that is easier to work with than Øland wheat and spelt, but is still not a modern variety, Ella is a good choice. There is less than 500kg of seed of this variety left. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Amy

Amy is another Swedish spring wheat from 1970 that, like the aforementioned Ella, was selected specifically for its fine baking quality. There is currently around 8 tonnes of seed left of this variety. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Peter and Paul’s Giant wheat

Peter and Paul's Giant Wheat looks a bit special, and in fact, like spelt, it is a completely different species (*Triticum petropavlovskyii*) within the wheat genus than common wheat, even though they are closely related. It’s also called Xinchang rice, even it is not a rice but a wheat. It's almost a kind of naked spelt, i.e. a grain that, like common wheat, doesn't need to be de-hulled, but still has characteristics similar to spelt. A curiosity for those who want something in their product catalogue that no one else has. Peter and Poul's Giant Wheat has growing characteristics similar to regular bread wheat with a decent yield and a usable baking quality. There is currently around 3 tonnes of seed left of this variety. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Sunshine Wheat

Sunshine Wheat is a spring wheat that produces yellow flour. The yellow colour is due to a high content of lutein, which is a healthy antioxidant that, like beta-carotene in carrots, prevents AMD eye diseases as it is a precursor to vitamin A. Sunshine Wheat has a hard, light-coloured kernel, similar to Durum wheat, but unlike durum, Sunshine Wheat has an elastic dough that is better suited for bread making. Please read more about Sunshine Wheat and lutein i January issue of The Landrace. There is currently around 1 tonne of seed left of this variety. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Pop Gazelle

Gazelle is the new hope for spring wheat production. Common spring wheat has become a risky crop because of the risk of high yield losses due to the chloropid gout fly. Pop Gazelle is very similar to Mariagertoba, but it emerges a little faster in spring growth and therefore provides good weed competition. Bunt resistance is also improved. However, the big advantage of early growth is also that it is less attacked by the chloropid gout fly. We therefore want Gazelle propagated, as we expect an increasing demand for a spring wheat with a lower risk of barley fly infestation. We currently only have 400kg, for which we are looking for a seed multiplication. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Durum wheat

Durum wheat is mostly grown in Mediterranean climates, where it is used for pasta, bulgur and couscous. This is because Durum wheat, with its very hard kernel, is better able to produce semolina and cracked kernels, while the softer kernel in bread wheat is more commonly used for flour. Experience with Danish durum is that it produces excellent quality, but yields are low and highly variable. Landsorten’s durum wheat variety is taller than the commercial varieties and better suited to the Danish climate, but it is still a durum wheat and you should be prepared for the fact that it does not have the same cultivation stability as bread wheat or spelt. Durum wheat does have the same tillering capacity as do bread wheat, and it is therefore recommended to increase the seed rate to improve weed competition. There is currently 500kg available. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Blue spring wheat

Blue spring wheat has kernels that are bright blue in colour. It looks exciting in a salad dish. Blue spring wheat flour gives baking properties similar to other spring wheat, but with a bread colour reminiscent of rye bread. There is less than 100kg of blue spring wheat seed left. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Purple spring wheat

Purple wheat is another good complement to regular wheat. In purple wheat, the colouring anthocyanine is in the bran, so purple wheat doesn't make much sense if the goal is to make sifted flour. However, the purple bran can be used as a natural colouring agent for other foods and is already used in beer brewing for this purpose. There are currently 5 tonnes of purple wheat seed

available. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Indian Shot Wheat

Indian Shot Wheat is a special type of grain that is very closely related to common bread wheat and spelt. However, the kernels are quite small, only half the size of regular wheat and characteristically circular. It's not good for regular bread baking, but it's great for pizza and fun to have in a salad bowl. Indian Shot Wheat has a high protein content, and with its small grains and high protein content, it may be relevant to use as chicken feed. There is 500kg of seed available of Indian Shot Wheat. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Allergy friendly spelt

Landsorten has obtained a spelt variety called 'E3' developed from a Spanish landrace of spelt that has a mutation that makes it free of expansin. Expansin is the protein that can cause hay fever (grass pollen allergy) and can also cause wheat/food allergy. E3 spelt is also low in fructan, which around 11% of the population have problems digesting. E3 spelt could therefore be a solution for some consumers who have trouble eating regular bread baked on modern bread wheat. In terms of cultivation, E3 spelt is similar to Danish spelt and other spring spelt varieties, which are slightly later in development than regular spring wheat. It is recommended to sow as early as possible. There are 2 tonnes of seed available for E3 spelt. Updated status of the seed situation will appear on Landsorten's website under Marketplace.

Amylina naked barley

Amylina barley is a naked barley from the German biodynamic plant breeder Cultivari, which has a high content of amylose. Most of a grain kernel consists of starch, and the starch itself consists of a mixture of amylose and amylopectin. The amylopectin is quickly broken down into sugar during digestion, but the amylose is resistant to digestion, and therefore acts as a nutritious substrate for our intestinal bacteria. It has been shown in recent decades that feeding the intestinal bacteria is extremely important for both our immune system and our mental health, so that dietary fiber and especially resistant starch such as amylose are important for our health. It is recommended to consume at least 30g of amylose per day, and Amylina barley is a good source to reach the recommendation.

Others have tried using NBT techniques to develop barley varieties with a high amylose content, but Amylina barley shows that you can do the same with ordinary organic plant breeding. The ratio between amylose and amylopectin is controlled by 3 genes. All three genes must be turned off, if a barley variety with 100% amylose in the starch must be made. Amylina is based on traditional organic plant breeding, where this is difficult, so only one of the genes has been switched off, so the amylose content is only slightly higher than in ordinary barley. At Aarhus University, CRISP technology has switched off all three genes in a barley variety, so that it has 100% amylose. It will also be possible to do it with traditional techniques if you find three landraces of barley in a gene banks, each of which has the three different genes turned off. From here, you can cross to a variety that contains all three genes, and it can then be crossed several times with modern varieties to obtain a variety with both the three genes and good cultivation characteristics. A good concrete example of what the discussion about CRISP is about.

Babushka

Babuskha is a naked barley with purple-coloured kernels. It has a good baking quality and looks beautiful in a salad bowl. There is 5 tonnes of seed available. Updated status of the seed situation will appear on the Landsorten website under Marketplace.

Malting barley

Landsorten has a hulled spring barley also comes from the German biodynamic plant breeder Cultivari. It has excellent growing characteristics for organic growing conditions, where especially weed competition is significantly better than the conventionally bred varieties. A very reliable variety that is suitable for both malt and feed. There are currently 4 tonnes of seed available. Updated status of the seed situation will appear on the Landsorten website under Marketplace.

Triticale Mary

The landrace triticale comes from Tasmania, and is therefore named after Crown Princess Mary, who also hails from there.

Triticale is a cross between wheat and rye, and in many ways, triticale is also a mixture of characteristics from both wheat and rye. Most triticale in Denmark is used for animal feed, but you can bake bread from triticale. The result is a bread that resembles rye bread with a little wheat flour mixed into the dough to improve its rising properties. The flavour is slightly milder than real rye.

The Mary triticale variety has been grown in Denmark since 2018 and has not yet been seriously affected by yellow rust, which is the most feared disease in triticale. Mary can be grown both as spring triticale and winter triticale. There are currently 150kg of seed available. Updated status of the seed situation will appear on the Landsorten website under Marketplace.

Oil seed oat

Oats with high fat and protein content. We have 2 tonnes of seed in stock. Updated status of the seed situation will appear on the Landsorten website under Marketplace.

Emka buck wheat

Buck wheat is not a wheat, but a gluten free pseudo cereal. There are different buckwheat varieties on the market. Kora is the most widely grown in Denmark. Emka is the buckwheat of Landsorten. It’s an old Polish variety that is later and more uneven in maturity than Kora, but it has larger kernels, is easier to de-hull and produces higher yields and more vegetative growth.

Please find previous issues of The Landrace at: https://www.agrologica.dk/publikationer