Let's make grain great again

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The Landrace

Newsletter no. 6
September 2021

The grain is harvested, and it is time to evaluate the year and prepare for the coming season. I've used to opportunity to write some of it down.

please enjoy reading

Anders Borgen

Headlines in this newsletter

General assembly in Landsorten.

The organisation Landsorten had the general assembly in June this year, and there is great support from farmers and millers. More than 60 participated in the event where they also had a look at Agrologica's cereal breeding, and had the opportunity to discuss the future of organic grain. The GA elected a new board, and Morten Øster Kristensen is now chairman of Landsorten. Morten runs his own farm and the mill Samsø Mel and was one of the first to grow the varieties that are now launched by Landsorten.

Landsorten now has more than 100 members and grain gown in 6 countries.

At the general assembly we had time to have a look at the cereal breeding of Agrologicas.

The growing season 2021

We had a hard winter this year, and in particular hard frost in January without snow cover. This was hard for varieties with poor winter hardiness, and a pity for farmers growing this kind of varieties. However, for Agrologica it is a unique opportunity to achieve information about winter hardiness and to improve populations. In particular in development of a winter hardy durum wheat, this year has significantly selected the best breeding lines. It was less fortunate that we too late found out that the field was poorly limed, and many plant suffered in the acetic soil. This gave huge problems with common windgrass and other weeds, which the participants in our open field days cannot have overseen.

We have now harvested and have started to analyse the grain. Most spring wheat has a protein content of about 14-15%, and the winter wheat about 12-14%. Protein content is rather high considering that it is grown on poor sandy soil, but this is partly because we grow the grain at 40cm row distance. With this high row distance, we try to mimic the conditions at better soils with hither clay content, where most wheat is grown.

Marketing of seed from Agrologica

It is still possible to buy seed directly from Agrologica, but it requires membership of Landsorten to buy Agrologica's seed. All former customers have joint Landsorten, so in future the conditions for trade is open and equal to all. Agrologica only have small seed samples for sale of rare breeding lines. The larger populations and varieties that are grown commercially can be ordered directly by the growers, or Agrologica can link you to one of them.

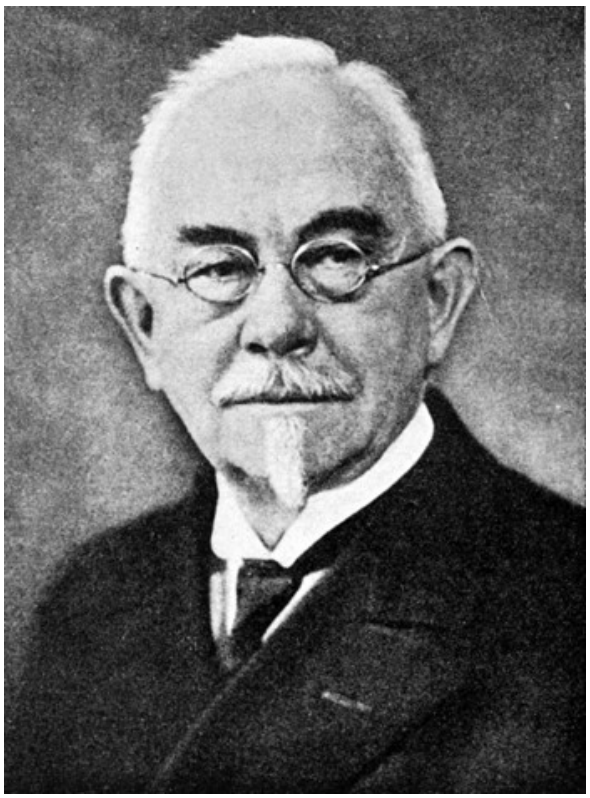
Varieties or populations?

The biosphere is divided into plants and animals, and the plants are divided into classes, families, genus and species. Species are further divided into sup-species, and the lowest taxonomic division in botany is the variety.

Wheat, barley and oat are self pollinating, and they will inbreed until they are 100% inbred lines. This means that all offspring will be identical with the parent. If you take a grain and multiply it, all plants and grains will be exactly identical, just like clones.

When a plant breeder crosses two varieties and let them self pollinate for 8-10 år, he will get a lot of inbred lines, and if kept apart they can all become a new inbred variety. Normally, the term variety is used for an officially approved inbred line, whereas a breeding line is the term before it has become officially recognised. However, botanically it is the same.

Landraces are the term to the cereals that were grown in the old days before commercial plant breeding. When plants have been grown in the same environment for a long time, it will adapt to the conditions, and the less adapted plants will disappear at least in frequency. A landrace is therefore a genetic diverse population, but with certain common traits based on the conditions where they have been grown.



It was the Danish botanist Wilhelm Johannsen (1857 - 1927), who in 1903 discovered the concept of pure line varieties in self pollinating crops. If all plant in a self pollinating crop like wheat, barley or oat comes from the same plant, then all plants will be genetical identical. Johannsen introduced in 1905 also the term ”gene” about heritable traits, at term that has been taken over in many other languages.

It is easy to make a pure line variety with specific traits. Just multiply some grains and select one that has the trait you’re looking for. It is actually more difficult to make a population with specific traits, because how do you get rid of the lines without the trait? If seed is marketed as not multiplying nematodes in the soil, it’s not good enough if only some of the plants are not multiplying the nematodes. In some cases, it is easier or necessary to work with pure lines, and Agrologica also sometimes develop pure lines.

When Agrologica develops populations, we do it by breeding a lot of inbred lines, and test all of them for baking quality and agronomic traits. Afterwards, we select all the lines that meet the criteria we want, and remix them into a population. It can also be called a complex variety mixture, a synthetic variety or a modern landrace.

By having genetic differences in a crop gives a synergetic mixing effect. Most variety trial shows an improved yield of a few percent compared with the components of the mixture. Another benefit is increased yield stability. If we again return to winter hardiness, there is little effect on yield if 10% of the plants die during winter, as the remaining plants can utilise the extra nutrients, water and sunlight. If most of the plants die during winter, they can't, and then the entire field need to be resown. If 10 varieties are grown, and one of them turns out to have poor winter survival then 10% of the fields need to be resown in the spring. If on the other hand the 10 varieties were grown in a mixture, then the other plants would be able to compensate for the winter kill. As an additive effect, if you use the mixture as seed for the following year, the mixture will have improved the winter hardiness, as the sensitive plants are gone.

It can therefore come as a surprise why at all seed is marketed as pure line varieties when it is scientifically proven that is on the expense of yield and security. One of the reasons is that it is not legal to propagate varieties in mixtures, but the seed companies have to propagate the varieties separately, and mix new mixtures each year. In Danish legislation, variety mixtures must be approved and may only contain 3-4 varieties. Agrologicas populations sometimes contain up to 100 different breeding lines, and none of them are officially recognised. Therefore, we call them population, not to confuse the term with conventional produced variety mixtures.

In the new Organic EU-Regulation taking into force in 2022, it will become legal to produce and market organic produced populations if they are recognised by the certifying body. In EU-terminology it is called Organic Heterogeneous Plant Propagating Material (OHM).

I will always recommend growing populations in favour of pure line varieties, especially in organic farming, unless there is a specific reason for growing it, or that populations with the required traits are not available.

Current available seed of winter crops from Agrologica

Of bread wheat for sowing in autumn 2021, **Popkorn** should be the first choice for most farmers. It is a mixture of a lot of breeding lines with good agronomic traits, including resistance to rust and common bunt, and with a high gluten index and protein content. The protein content is a few percent point higher than conventional bread wheat varieties to compensate for the lower nitrogen supply in organic farming.

Another crop widely grown among Landsortens members are **Viola**. It is a purple wheat, with beautiful purple-brown kernels.

There are a couple of new populations and varieties this year with different traits:

- **Pop Karse** (cress)is a population, that in many ways resembles Popkorn, men with shorter straw, and therefore better suited for a high fertilise level to prevent lodging.
- **Pop Himmelblå** (blue sky) is an absolute novelty in Denmark: Wheat with blue kernels. It is kind of the same blue colour that are known from rye, but with a much more intense colour, and a characteristic taste similar to blueberries.

- **Pop Foder** (feed) is a population with a high yield potential. A first choice for organic farmers growing wheat for feed purpose, but it can also be used for cakes where a too high protein content is a disadvantage.
- **Pop Fit-nisse** is a population with an extra hig protein content, even higher than Popkorn. and other populations bred for bead baking. Well suited for grown under low input conditions.
- **Goldritter** is a German variety with a low content of ATI (α-amylase tripsin inhibitors). ATI is one of the substances in the flour that can provoke bakers asthma and wheat allergy or intolerance. German trials indicate that some consumers tolerate Goldritter better than other wheat varieties. The variety is tall and with good baking quality. Please read more about ATI and other health related issues of wheat consumption here.
- **Pop Nørregade** is a population that in agronomic performance resembles Popkorn, but it has a more smooth dough with a gluten index of about 80. For home baking and common consumers **Pop Nørregade** will probable be better suited than Popkorn, who with the high gluten index are more appealing to professionals and baking nerds.
- **Bagespelt** (baking spelt) is a new spelt variety with a higher gluten index than most spelt varieties such as Oberkulmer Rotkorn. Often it is difficult to bake with spelt flour if not mixed with bread wheat because the gluten index is so low that it is difficult to maintain the shape of the bread. Bagespelt therefore has a better in baking quality for standard baking bread types.

Agrologica has other varieties and populations in propagation, but these are already reserved or more or less out of stock. However, if you wish one of these, you may be lucky to get a small sample for your own multiplication, or you can make a reservation for seed for next season.

With 26cm, Baking Spelt again produced the longest ear in the field this year.

- **Pop Giraf** is a population that is taller than the other populations and therefore well suited for growing at high weed pressure and low input conditions.
- **E3-spelt** is like Goldritter recommended for consumers with intolerance to products of common bread wheat. However, the reason is different and it is therefore different consumers that may be able to tolerate the one or the other, depending on which problem they have. E3-spelt has a low content of fructan, which like other FODMAPs courses IBS (Irritable Bowel Syndrome) with symptoms like bloating and stomach. It is estimated that about 11% in Western societies suffers when eating wheat because of IBS. E3-spelt is also free from expansin, a protein is a key substance in grass pollen allergy and hey feber, and also coursing wheat allergy when eating it. Please read more about expansin, IBS and other health related issues of wheat consumption here. In baking quality, In baking quality, E3-spelt is similar to Oberkulmer Rotkorn, which also is rather low in fructan. Even though

Oberkulmer Rotkorn has a normal wheat like content of expansin, some consumers tolerate Oberkulmer Rotkorn better than normal bread wheat.

- **Pop Mongo** is not only a new population but an entirely new crop. It is an exotic wheat species called *Triticum petropavlovskyi*, with an origin in Western China and Tibet. The kernels are big, similar to spelt, but it is free threshing like bread wheat and need therefore no de-hulling. The baking quality is good with a gluten index about 80. A good choice if you want a spelt like crop, but have limited access to de-hulling equipment.
- **Dansk Spelt** is the on spelt variety with a Danish origin. In baking quality it is similar to Oberkumler Rotkorn.
- **Othello** and **Pjerrot** are two populations of white wheat, characterised with mild taste and gives extra white flour. Well suited for whole meal and if you want to produce white flour on a stone mill. Pjerrot has a higher protein content than Othello, and Pjerrot is therfore better suited for bread baking, whereas Othello is better for cookies and cakes.

Agrologica's projects

Alongside with the plant breeding, Agrologica participates in several research and development projects financed by public support schemes.

DIVERSILIENCE

DIVERSILIENCE is a new project starting up in 2022 with support from the CoreOrganic-program. The project is a cooperation between institutions in Norway, Finland, Rumania and Italy, and the topic is to increase diversity and resilience in organic crop production, both within crops and between crops. Agrologica's role in the project is among others to breed white lupins adapted to Scandinavian climate, species mixtures and to continue ongoing work to develop genetic markers for bunt resistance. Also, we will investigate how resistance and virulence develops over time in response to increasing genetic diversity in mixtures.

The project "Stinking smut"

The project is financed by Promilleafgiftsfonden. In 2019 and 2020 we tested all wheat varieties in the Danish Seed Catalogue for resistance to common bunt. Unfortunately, there were very few surprises. The most resistant varieties were Hallfreda, Festival, Fritop and Initial, which was as resistant as our own populations. Hallfreda and Festival are bred by Landmännen in Sweden and are in particular used in areas with dwarf bunt. Dwarf bunt is only occurring in few places in Europe with extensive snow cover during winter, but the resistance gene are the same for dwarf bunt and common bunt. Our research demonstrate that Hallfreda and Festival have the same resistance genes than Stava, and we believe these are Bt8 and Bt9. We will test this in further detail in DIVERSILIENCE in the coming year. The variety Fritop is marketed by Nordic Seed and is bred by the excellent biodynamic breeder Karl-Josef Müller at Cultivari in Germany. Most likely, Fritop has a combination of BtZ and Bt7. As a kind of surprise, the variety Initial, turned out to have resistance gene Bt5. To our knowledge, the variety is not bred with bunt resistance in purposes, but sometimes you can be lucky, I guess.

If a variety has only a single resistance gene, it will be protected against most bunt spores in the environment, but not against all of them. There are fungal races out there, that can infect varieties with resistance, if they have virulence against the resistance gene in the variety. Even though a variety has a resistance gene, it is hence not a 100% guarantee that it cannot be infected. And once a resistant variety is infected by a virulent race, then the disease will multiply within the variety just as fast as if the variety was fully susceptible. Monogenic resistance is just like a luck in a door. It keeps out most thieves, but if a thief has a key, the house is not protected. If a variety has two different resistance genes, the risk is even lower, but still there is a risk.

Modern varieties are genetic uniform. This is just like if all housed in a town uses the same luck in their doors. If a thief has a key, he can freely enter all houses in the town. Monogenic resistance in a uniform variety may be better than nothing, but it is a high risk game, and it is not durable as there is a high selection pressure for the diseases to develop virulence. In conventional seed industry we therefore often see varieties being replaced after only a few years on the market. They start being resistant and high yielding, but after a few years they loose their resistance, and need to be replaced with other varieties with other resistances. An extreme case of this phenomena was the variety Benchmark being the most grown variety in Denmark a few years ago and fully resistant to yellow rust, but in 2019 virulence developed, and Benchmark is now one of the most susceptible wheat varieties on the market to the current race of rust.

To minimise the risk of virulence development, Agrologica uses populations with many different resistance genes in each. The different houses in the town have different lucks. This includes both advantages and disadvantages. For a thief, it is actually easier to find a house where his key fits, and the key will also fit with other houses, but at least not to all other houses. So, there is a slightly higher risk of small infections, but a lower risk of serious infections. And certainly better than conventional varieties with no resistance at all. In the project DIVERSILIENCE we will work further with the resistance strategies, and find an optimal balance between preventing infection (pathogenesis) and disease development (Epidemiology).

ØKOSORT-II

In the project ØKOSORT-II, Agrologica cooperates with Nordic Seed to develop varietes for organic farming. Nordic Seed works in particular with genomic selection with focus on spring wheat and spring barley. The tested lines comes from both their own conventional breeding program and from Agrologica's organic breeding program.

Genomic selection is a bit different than Marker Assisted Breeding (MAS). When Agrologica in the LIVESEED and other projects tries to develop genetic markers for bunt resistance, it is for marker assisted breeding, used to predict if a variety has a resistance gene or not. Genomic selection is mainly about yield and other traits determined by the sum of many genes, each maybe only with a minute additive effect. Therefore it is more about a complex statistical estimate to the trait from each gene. Nordic Seed and most other modern conventional breeders already have models for their conventional breeding programs, but in ØKOSORT-II we will see how well these models fit to organic conditions in terms of prediction yield under these conditions.

Apart from delivering germplasm to Nordic Seed for trial in their genomic selection models Agrologica tries in this project to breed for Cereal Cyst Nematode (CCN) resistance. Nematodes in the soil is a soil borne disease and becomes a problem when growing too much spring cereal spring crops. This was the case in the 1960'ties and 70'ties in Denmark where Denmark had huge problems with nematodes. Since no pesticides can control nematodes, the breeders developed resistant varieties of barley and oat. However, not resistant spring wheat varieties has been

developed in Europe, since nobody grew spring wheat in Denmark, until the organic farmers started. In USA and Australia, resistant varieties have been described, and Agrologica has crossed some of these with local varieties attempting to develop a local adapted nematode resistant variety. This year, some of the breeding lines have been tested at Tystoftefonden, who has test facilities for nematodes. We are very curios to see if the exotic resistance mechanisms are also effective to the Danish races of nematodes. Preliminary results are looking very promising, but with nature a sound scepticism is often more realistic.

In ØKOSORT-II, Agrologica also works with lentils. We have collected lentils from here and there and tested them I field trials. This year we have grown 70 varieties and breeding lines. In colour and size they are very different, but in growth habit, it is all more crap and difficult to grow. Lentils do tolerate low temperatures, but they are weak plants unable to stand by themselves, and even when grown mixed with other plants, that are very poor in climbing on these mixing partners. Therefore, it is difficult to find the right balance between lentils and mixing partners. Cereals are not good a helping lentils up from the ground, and when grown too dense, the cereals are very aggressive in competition with light and water. It is not the objective for Agrologicas to develop new cropping systems for lentils, but it is important for us to understand the nature of the crop to develop improved varieties fitting the cropping system. We have tested also winter sown lentils. The survived the winter quite well, bur started re-growing too late in the spring, and we concluded that weed therefore would to too big a problem for organic winter lentils in Denmark.

Linser grown in pure stand.

LIVESEED

LIVESEED is a EU-project (H2020), that is now about to be finish. In the project, Agrologica has mainly worked with development of genetic markers for bunt resistance. The work is to be continued in DIVERSILIENCE amongst others.

Healthy forgotten grain

The Project build on a previous project Forgotten Grains, where Agrologica different rare exotic varieties and species, The wheat species are described in the previous number of this newsletter. In th project Healthy Forgotten Grain, we investigate quality parameters of the same grains. We get help from Copenhagen University for some of these analysis.

ProBioWheatGrass

In ProBioWheatGrass, different partners including FoodJoy and ISI Food Protection have cooperated in developing wheat grass for human health and consumption, and Agrologica has assisted in finding the best varieties. However, I will not take too much of the credit, because we found out the growing and processing had much more influence on quality than the varieties. The project is terminated in summer 2021.

Nordic/Baltic cereal meeting 28th-30th October 2021 in Norway

The annual Nordic cereal gathering will run the 28th-30th October at the agricultural university in Ås south of Oslo, Norway. These meetings are unique importunities to network and get inspiration about organic and heritage grains. The organisers have made a proper homepage about the event: https://www.nordicgrainconference.com/. Since you have been reading this entire newsletter without complains, I'm sure you'll enjoy this event too about the same topic. For those unable to attend, there will be some kind of virtual access. Please note that an early bird discount will be given until 18th September.

The Nordic cereal seminars build on a long tradition. Already in the 1970'ties, the biodynamic millers and bakers in Scandinavia met regularly. In 2008 the first seminar was organised in Roskilde, Denmark to include a broader range of participants including farmers, researchers and others, and since then it has been an annual event every year except the corona-year 2020. In 2019 the event was help at Kalø, Denmark together with a similar European event, Let's Cultivate Diversity, which has been help in other a couple of times previously in different European countries.

The 2021 meeting will be a Nordic and Baltic event which means that the languages will be both English and Scandinavian.

God vækst for alle i 2021